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## THE GIRARD-AVENUE BRIDGE.

(Continued from page 28.)

ALL points of contact are either planed or turned. The pins are of cold rolled iron, and the limit of error between pin and hole is one sixty-fourth of an inch.

The iron used in this bridge is double refined, or of "Phœnix best best" brand, capable of bearing the regular tests of that quality of iron as follows: Ultimate strength, 55,000 lb. to 60,000 lb. per square inch; no permanent set under 27,000 lb. to 30,000 lb. per square inch; average reduction of area at point of fracture, 25 per cent. The elongation of a 12-in. bar is 15 per cent, and the cold bend of a 1¼-in. round bar before cracking 180 deg., or hammered flat.

*Roadway.*—The corrugated iron plates which cover the bridge are themselves covered by 4 in. to 5 in. of asphalte, making a water-tight surface. The 100 ft. of width is divided into 67½ ft. of carriage-way, and two 16½ ft. sidewalks. The roadway is paved with granite blocks in the usual manner, except that it is divided into seven ways by two lines of iron trackways next the sidewalks for horse-cars, and five lines of carriage-tramways, made of cut granite blocks, 1 ft. wide, laid to a 5 ft. gauge. The gutters and curbstones are of fine cut granite. The sidewalks are covered for 10 ft. of their width with black Lehigh County slate tiles, 2 ft. square, laid diagonally.

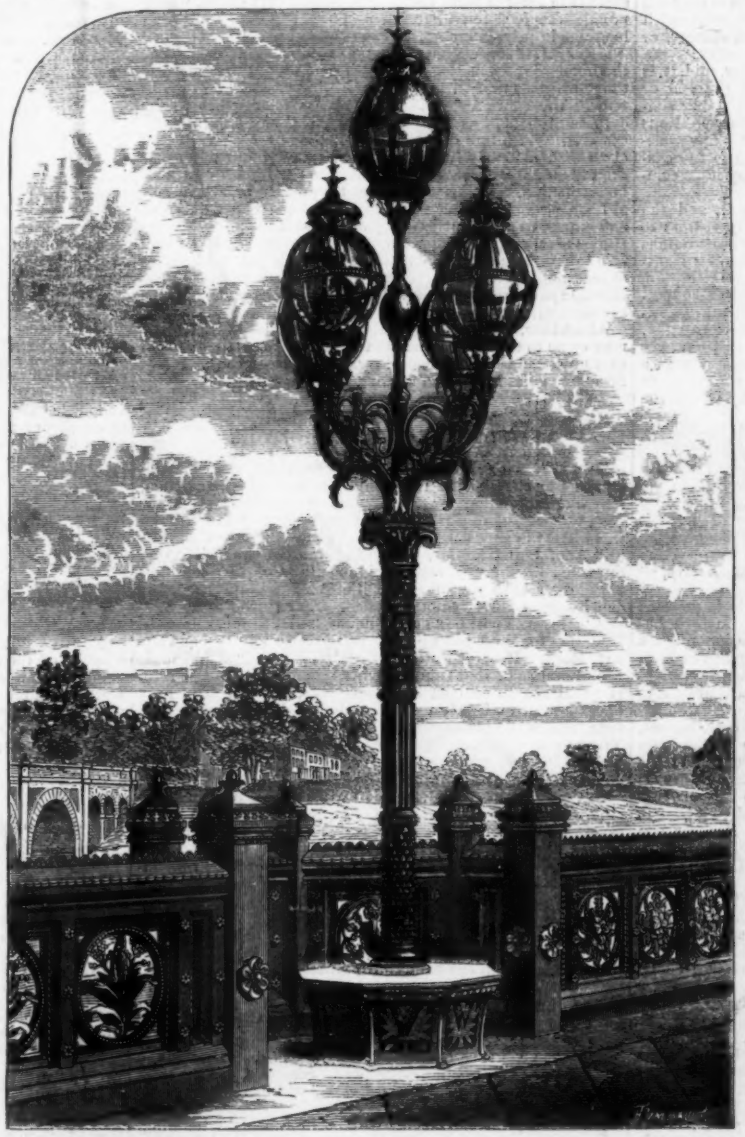
On each side of the slate tiles are spaces 2 ft. wide, which were originally laid with encaustic tiles. After one winter's frost these tiles became so much shattered, that they were removed and white marble tiles substituted in their place. The curbstone 18 in. wide makes up the remainder of the 16½ ft.

The sidewalks are separated from the roadway by railings of galvanized iron tubes with bronze ornaments, and are supported by cast-iron standards at every 6 ft. Every eighth standard is prolonged into a lamp-post. There are eight refuge bays, each of which contains a cluster of six lamps (see engraving, page 49), the supporting shaft rising through an octagonal seat, which forms its base. The outer balustrade and cornice is of cast-iron with bronze openwork panels, and treated in a highly ornamental manner.

The bronze panels (see detail view, page 52) represent various birds and foliage, such as the phœnix, swan, heron, owl, eagle, tobacco, ivy, Virginia creeper, ferns, and hops. These panels are of statuary bronze cast under a pressure of 60 lbs. per square inch, which forces the metal into all the finest lines and makes an extremely sharp casting; so sharp, indeed, that a casting made by this process from an electrotype has been used to print engravings from. There are between eight and nine hundred of these bronzes set in the balustrade, like pictures in a frame.

It is intended, at some future day, to place sidewalks inside the bridge, at the level of the lower chord. Access to these will be gained through the arched openings in the abutments, and this spot has been selected as a proper place for a drinking-fountain. The bridge is painted salmon color, relieved by blue and gold; the cornice and balustrade are green and gold.

This bridge, notwithstanding its thorough construction and its large dimensions, was built in a remarkably short space of time as compared with works of similar magnitude. As the new bridge occupied the exact site of the old one, it was necessary, first, to build a temporary bridge 1050 ft. long and 50 ft. high above water, divided into spans of 100 ft. each, resting on wooden cribs filled with stone. This was done in six weeks.



THE GIRARD-AVENUE BRIDGE, PHILADELPHIA, PA.

The construction of the permanent new bridge began May 11th, 1873, and July 4th, 1874, it was formally opened for public travel, and has remained in use ever since.

This rapidity of construction is due, first, to the mode adopted of laying the foundations under water, instead of pumping out that water; second, to the forethought displayed in making the temporary work strong enough to pass uninjured through a freshet which increased the depth of water from 30 ft. to 46 ft.; third, to the peculiar construction of the girders (which contain over 3500 tons of iron), which were made at Phœnixville from the ore, entirely by machinery, and without any hand labor; and, lastly, to the rapidity and facility of erection allowed by the pin-connected mode of construction.

The general dimensions of this bridge were fixed by Mr. Samuel L. Smedley, city engineer, of Philadelphia; while the design and construction are by Messrs. Clarke, Reeves & Co., of the Phœnixville Bridge Works, whose iron bridges and viaducts are known in all parts of the world.

The full description of this splendid work, with ten illustrations, is contained complete in SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1, 2 and 3, for 1876.

## NOTES OF ATLANTIC AVENUE (BROOKLYN) STEAM STREET-CAR, 1 P.M. TRIP, JANUARY 1, 1876.

MACHINERY made by Baldwin Locomotive Works, Philadelphia, Pa.

The car is new, of same size as ordinary two-horse street-cars, but somewhat stronger; wheels, 30 inches diameter; weight of whole, six tons.

Boiler, upright tubular, thirty six inches diameter, five feet high, stands in the door, at one end of the car, and is well cased to prevent loss of heat. Number and size of tubes could not be ascertained.

Two engines, six by ten inches, fitted to under side of a cast-iron plate, which is bolted to the under side of the bottom of the car, and located between the axles, the cylinders being near the rear axle and coupled to cranks on the front axle.

Valve-gear of the locomotive style, reversing and varying the cut-off; worked by lever at front platform, where the brake-lever and throttle-valve lever are also arranged so that the engineer has easy command of all three while sitting on a comfortable seat.

The brakes are very powerful, being suspended between the front and rear wheels from the car-body, and connected by toggle-bars with the rock shaft worked by the engineer's lever.

A condenser is used to break the exhaust, consisting of a couple of galvanized-iron tubes about six inches diameter, arranged longitudinally alongside of the engine, and connected with a heating coil under the seats. The water condensed in these large tubes is allowed to escape while the steam not condensed passes through the heating coil, and finally escapes through a blower in the smoke-pipe to assist the draught. The noise of the exhaust is hardly perceptible, and the quantity of steam discharged is very small.

Started from Flatbush avenue at 1 P.M. with another car hitched on, both being well loaded, but not overcrowded. Steam, 110 pounds. Motion quite as easy as horse-car, except the jars were a little sharper, owing to the greater weight; but except when running quite fast, say a brisk horse-trot, no shaking motion due to the engine was perceptible, and the little felt when going fast was not at all uncomfortable. Stopped quite as quick as a horse-car, and when on the level, and even on light grades, while steam remained as high as 100, started about as quick as horse-car and with less shock. For about a mile and a half, the way was mostly up-grade, but not very steep. Near the end of the up-grade, steam had fallen to about 70 pounds, and the speed fell very slow, almost stopping. Two horses to each car would have moved along this grade at a slow trot with the same loads. The rest of the way was more level, and there was no difficulty in making good time and starting well enough. Seventy pounds of steam at the end of the route, which is about five miles; time half an hour, little faster than regular horse-car time.

Returning, started with steam 110 pounds, but fell to 70 in a mile and a half or so. Stopped on a little grade, and failed to start, when steam was let on. Reversed the valves and tried to start back, and then catch the cranks at the most favorable point for starting, several times, but did not succeed in starting for some two or three minutes. The rest of the way made good time, and had no difficulty in starting except being a little too slow in some cases.

The machine seems quite as easily controlled as a horse-car, if not easier; is capable of propelling itself with certainty, and starting on any grade on the line, with any load it can contain, but with another car hitched on is uncertain.

It does not scare horses much; those attached to other cars seem more affected by it, and in some cases the car-drivers stopped and held the horses.

In starting, the engineer sets the link to give the valves full throw, and shifts the throttle-valve wide open; but when the required motion is attained, he shifts the link-lever from one to three notches (of about eight notches) towards the centre, and then closes the throttle as demanded, and regulates the motion by it.

The boiler appears to be about ten-horse power. The engines working full stroke, running eighty turns a minute (about seven miles per hour), develop 23 effective horse-power, but at starting they seem to develop with 70 pounds about 3-horse. Practically, steam is not worked full stroke when running full speed, as no such amount of power is required, and the boiler would not furnish the steam. Consumption of coal, as near as ascertained without careful measurement, considered to be 500 pounds for 10 hours' running, without another car.

## PHOTO-COPYING.

By JOHN NICOL, Ph.D.

COPYING is every day becoming a more and more important part of the work of a professional photographer, and sometimes the operator is sadly puzzled with his attempts to contrive a satisfactory method of lighting the picture to be copied. Of all the methods I have seen, the following, which I saw in operation in the studio of one of my friends, is, I think, the best, both for simplicity, economy, and efficiency: It consisted of a rough deal board, about eight feet long and fifteen inches broad. One end of this rested on the floor, and the other on a table, by which arrangement any desired angle could easily be attained. At the lower end of the board there was firmly nailed, at right angles, a piece of wood fifteen inches square. The print, kept flat by being placed in an ordinary printing-frame, was placed against this foot-board, so that it was exposed to the action of both the top and side-lights of the studio. The focus of the lens being known, and the size of the copy determined, it was only necessary to adjust the distance between the lens and the ground-glass, and then slide the camera up or down the board till the proper focus was obtained, when it was kept in position by a nail. By this arrangement first-rate work was being rapidly done, although the adjustment of the various planes might be made more easy of accomplishment by the expenditure of a few pence on the improvement of the apparatus. The board should be planed, and have drawn on it a few longitudinal lines as guides to the camera. Long strips of wood would be better; but then only one camera could be used, and a mere pencil-line would show perfectly when the camera was square on. The same arrangement reversed would answer admirably for making lantern pictures from large negatives, if the foot-board had an opening cut in it in which the negative could lie. Those who bother themselves with cumbrous copying cameras, under the impression that it is necessary to cut off all light except that which comes through the negative, should give this method a trial; and I know they will find that in this, as in most other matters, simplicity and efficiency go hand in hand.

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## HOW THE MULTITUDE WILL BE LODGED AND FED.

AN almost fatal blow was given to the Vienna Exhibition by the rapacity of the hotel and lodging-house keepers, and thousands are asking whether the Philadelphians may not repeat the criminal blunder. Will they be satisfied with a reasonable profit from the millions of expected visitors, or will they combine to fleece them?

Human nature is much the same the world over, and it is useless to expect men not to take advantage of the real or supposed necessities of others. Consequently, intending visitors to the Exhibition are likely to trust more to conditions which will make it difficult, if not impossible, for any general system of extortion to be adopted, rather than to the wisdom and humanity of those into whose hands they must commit themselves.

Happily, such conditions are likely to prevail, and the possibility of a state of things such as the early visitors to Vienna experienced is exceedingly remote. The preparations making for the accommodation of the hosts of coming sightseers are so ample that excessive competition is altogether unlikely, and there is correspondingly little danger of an opportunity for extortion even if there were any general disposition that way, which we certainly do not believe to exist. Besides, the facilities for living away from Philadelphia, yet within easy reach of the Exhibition, are so abundant that a spirit of robbery would have to pervade a vast area to make the practice of extortion feasible in any locality within the city or in the outlying towns.

From being relatively deficient in hotels and lodging-houses, Philadelphia has suddenly developed a capacity for feeding and lodging transient multitudes, sufficient apparently for any emergency. This improvement has been effected in various ways, by the enlargement of the existing hotels; by the construction of a number of new ones, some of gigantic dimensions and slight construction, intended for the occasion simply, others composed of blocks of houses, to be converted into private dwellings when the rush is over; and, lastly, by an enormous multiplication of private lodgings.

Of the first sort of preparation, a good example is afforded by the leading hotel of the city, the Continental, which has been thoroughly renovated, and enlarged to the extent of a hundred new sleeping-rooms. In addition, the proprietors of the Continental have erected a magnificent branch house opposite the western end of the main Exhibition Building, to be managed in connection with the house in town. The guests will have the privilege of staying in either or both houses, and will be transferred at will from the one to the other without trouble or expense. The hotel next in grade, the Girard House, has not only been enlarged, but its capacity increased by the engagement of 150 rooms in neighboring private houses. The St. Stephen's, the Colonnade, La Pierre, the Bingham, and the St. Cloud, have all been more or less enlarged and refitted in anticipation of the summer's business; and the same may be said of the smaller hotels, as the American, the Merchants', St. Elmo, and the rest.

Chief of the new hotels of the regular type is the Globe Hotel, nearly opposite the main entrance of the Exhibition grounds. This mammoth establishment has a frontage of 320 feet and a depth of 240 feet, is four stories high, and contains upwards of a thousand rooms. The kitchen, 80 by 160 ft., is of corrugated iron, and has a tall chimney to carry off the odors of the cooking. This house is expected to accommodate upwards of three thousand guests, and to provide in emergencies for as many as five thousand. In its huge dining-rooms, over two thousand persons can be served at once. The building is of the lightest possible construction consistent with the required strength, and will be removed when the Exhibition is over.

Quite as favorably situated, and of higher grade, is the United States Hotel, a square south of the Exhibition building. It is composed of two long rows of three-story brick houses joined by a shorter row of four stories high, all intended to be converted into dwelling-houses when their use as a hotel is at an end. At present the outside doors are closed, the dividing walls are pierced in the centre, and temporary cross partitions are put in so as to make a wide corridor on each floor, running the whole length of each row of houses, with rooms opening from it on either hand. Two of the larger houses have been thrown together for the office and parlors. The dining-room is a two-story brick structure occupying a part of the courtyard. The number of rooms is nearly three hundred, practically under one roof, though intended ultimately to be cut up into separate dwellings.

In the other dwelling-house hotels the guests can enjoy still more fully the privacy of home, as the houses are kept distinct, so that a family or a party of friends can have a house all to themselves, taking their meals at their own table, yet enjoying all the benefits of the hotel system. The largest of these establishments is the Grand Union, in the northern part of the city, near the crossing of the Pennsylvania and Germantown railways. It consists of ninety separate houses, in three rows, sixty of them three stories in height, with stone fronts, and thirty small two-story brick cottages, and contains 850 rooms. The space between two of the rows is occupied by a large one-story dining-hall, with a two-story structure for office, parlors, reception-rooms, etc. Each house is in electric connection with the office. Near by is an old mansion, with eight acres of shaded grounds, which has been leased for promenading and croquet, and immediately adjoining is a field of sixteen acres for military camps. Trains will run to the Exhibition grounds in ten minutes. It is expected that this house will be largely patronized by military organizations and civic societies.

Another dwelling-house hotel of high rank is the Aubrey, on Walnut street, West Philadelphia. It is composed of twenty-six houses in a row—the end houses and the two central ones four stories high, the rest of three stories. Back of the central block will stand a three-story frame building, with kitchen on the ground-floor, a dining-room, 50 by 200 ft., on the second, and servants' quarters on the third floor. The Aubrey will be conducted on the European plan, and will have accommodation for about 400 guests.

At the corner of 17th and Diamond streets a row of twenty houses has been converted into a hotel, on the general plan of the United States, and containing about two hundred rooms. It will be well suited for the accommodation of families who expect to make a long stay, and wish to be out of the bustle of the city, yet not too far from the Exhibition.

For those who wish for less expensive quarters, the Centennial Home, west of the Exhibition grounds, will be especially adapted. The Home consists of 140 small houses in three rows, with a common kitchen and dining-room. In one of the rows the houses will contain eight rooms, in another seven, in the third five rooms. As this hotel-village is but ten minutes' walk from the Exhibition, with street-cars for such as prefer them, it is expected that it will be largely patronized by exhibitors and their employees.

In addition to the larger hotels, there will be many small ones, with a larger aggregate accommodation for guests of modest means, while in and around the Park will be numerous restaurants, which will furnish refreshments to thousands of transient visitors. A mammoth establishment of the latter sort is the International Restaurant on Chestnut street, which promises to feed ten thousand people a day, and to furnish lodgings in private houses for twenty-five hundred.

After all, it is probable that these and other extensions of the hotel accommodations of Philadelphia will not suffice for the multitudes that will require to be housed and fed. There remain the spare rooms in private houses, of which Philadelphia probably has a larger number than any other American city. With two thirds the population of New-York, the city numbers nearly twice as many houses, and many thousand householders can be counted on as willing to turn an honest penny, for patriotism if not for profit. The Centennial Lodging-house Agency has canvassed the city with care, and expect to make such arrangements with the railway companies that, on purchasing tickets, the traveller will be able also to purchase coupons entitling him to board and lodging at reasonable and fixed rates. Even if half or quarter of the 100,000 spare rooms of the city can be so commanded, the problem will have been solved.

Altogether, therefore, it is fairly evident that millions who may come to the Exhibition will find food and shelter, and that no combination is possible whereby prices can be raised far above what is fair and reasonable.

## SWEDEN AT THE EXHIBITION.

THE *Tribune's* Philadelphia correspondent describes at length the character of the exhibit to be made by Sweden, whose appropriation for the Exhibition—$125,000—is larger than that of any other country in proportion to her population. All the goods are on the way, and will arrive about the middle of January. Mr. C. Juhlin Dannfelt, the Chief Commissioner for Sweden, says that the exhibit will be considerably larger than that made at the Vienna Exposition, the articles from Norway not included. Among the more interesting articles will be a school-house, built of timber brought from Sweden, and put up between the Jury Pavilion and the Art Hall. It will be a *fac-simile* of the best common school-houses of that country, with this exception—the interior will not be divided into two rooms, but will form only one, in order to display to better advantage the school-furniture, charts, and apparatus. The Swedish school-house at Vienna cost 6000 crowns, and was the admiration of all who visited it. For the Philadelphia building, 25,000 crowns, about $7000, are appropriated.

In the Art Department, Sweden will have 96 paintings, including works by Waldberg, Count Rossenberg, and many other well-known artists. In the Machinery Hall, among other things, she will have a new mitrailleuse, lately adopted by the Governments of Russia, Italy, and Denmark; an ingenious machine of recent invention for cutting corks, two or three steam-engines, and a railway-locomotive. A small iron steamboat, like those used for passenger travel on the numerous canals of Stockholm, will also be shown. Application has been made to the city authorities for permission to run the boat upon the Schuylkill, where it is believed it will prove its superiority to the craft now navigating that stream. In the Agricultural Hall the Swedish section will embrace a good display of farm products, a collection of fishes in glass jars, and a few machines and implements. There will be a reaper of novel construction, which the Commissioner thinks can compete with the best American harvesters, and the Swedish ploughs, much in favor in Russia, will be represented by numerous specimens.

Sweden's principal display will be in the main building, where her extensive iron and steel industries will be fully represented. A single manufacturer applied for one seventh of all the space allotted to Sweden for all purposes, but of course he got only a small fraction of what he asked for. After England, the United States is the best customer the Swedish iron-masters have. Woolen goods will be the next most important feature. There will also be fabrics of silk, cotton, and linen. The match manufacturers will make a fine show, and the potteries of Gustafsberg and Rörstand will send admirable specimens of porcelain, faience, Parian, and Majolica ware. Paper and card-board, made from pine wood, will be among the interesting specialties. Thirty costumed figures of life-size, representing peasant life in the different provinces of the kingdom, will attract much attention by their faithful portrayal of the dress and manners of the Swedish country people. They were modelled from paintings by distinguished artists. A number of articles of a fine red granite, that takes as high a polish as the well-known Scotch granite, will be exhibited; and among the manufactures of the beautiful porphyry found in Elfdal, in the province of Dalarne, will be a table belonging to the King, which cost $10,000. A meteorite, weighing 10,000 pounds, sent by the discoverer, Prof. Nordenskoeld, will attract the notice of scientific men.

The Swedish Department, as a whole, will interest the student of political economy as an exhibit of a country which cherishes the theory of free trade, levies its tariff duties chiefly upon sugar, coffee, tobacco, and spirits, and is content to limit its manufactures to such articles as nature has given it peculiar facilities for producing. Commissioner Dannfelt has been engaged in exhibition work ever since the London World's Fair in 1862. He says that the preparations for the Centennial are characterized by an intelligence, system, and dispatch that is worthy of high praise. The buildings he thinks better adapted for their respective uses than were those of any previous exhibition. Mr. Dannfelt has brought from Sweden several rare books on the early settlement of America, which ought to find their way into the libraries of some of the historical societies here. Among them is a Lutheran catechism, printed in Stockholm in 1696 in the language of the Indians who inhabited the country around the Swedish settlements on the Delaware.

## EXHIBITION NOTES—DOMESTIC.

THE special building for the shoe and leather display is to be 300 feet by 160 feet. It will be situated on the south side of Machinery Hall. The shoe and leather trade guarantee the sale of stock enough to cover the cost of construction—$30,750.

FEW objects will attract more attention, especially among foreign visitors, than the new ice-yacht just finished for Commodore Grinnell, of the New-Hamburg Club, in response to an invitation from the Centennial Commission. It is a fine specimen of Hudson River ice-boat, sloop-rigged, and built of clean white pine; the side-pieces cased with black-walnut, ornamented with gilt beading. The keelson is strengthened with a black-walnut truss; the deck is of narrow, closely-jointed strips of red cedar and spruce, and the iron-work throughout nickel-plated.

AN international regatta, under the auspices of the United States Centennial Commission, and open to all yachts belonging to organized yacht clubs, will take place in the harbor of New-York, on or about June 22, 1876. The Centennial Commission will award medals and diplomas to the winning yachts of each class, in addition to the prizes offered by the yachting organizations. The arrangements for this regatta have been placed in the hands of the following committee: George S. Kingsland, Commodore of the New-York Yacht Club, Chairman; John S. Dickenson, Commodore of the Brooklyn Yacht Club, Secretary; John M. Forbes, Commodore of the Eastern Yacht Club, Boston; W. L. Swan, Commodore of the Sewanhaka Yacht Club; W. T. Garner, Vice-Commodore of the New-York Yacht Club; S. Nichol Kane, Rear-Commodore of the New-York Yacht Club.

HON. A. J. DUFUR, Commissioner for Oregon, has made a fine collection of native timbers from the Pacific Coast for the botanical department of the United States display. Among them are sections of western pines, larch, cypresses, nutkanus, and other valuable timber trees. He intends to visit the lower Columbia for sections of the large trees in that region. J. G. Gerding has made another collection of woods to be exhibited by the Southern Pacific Railroad Company. These are from Mexico, and include samples of white, black, gray, and curled walnut, all susceptible of a fine polish; a sample of engravers' wood, called muela, extensively used by the illustrated journals of this country and Europe; the fecomate, a ship-building wood, said to be equal in strength and durability in water to the best live-oak; the lance-wood, formerly used for spears by the savage tribes that inhabited the forests of Mexico, and now extensively used in the manufacture of flutes and other musical instruments. The collection embraces also many samples of ebony, black mesquite, linolu, bloodwood, aveliana, prima vera, granadillo (a rosewood), acatipan (a yellow rosewood), cabano (a mahogany for veneering), linolue (scented), and hulagean, beautiful in grain, and susceptible of the highest polish.

A PHILADELPHIA carpenter, William H. Nicholas, has made a model of the (unfinished) national Washington monument, using 6385 pieces of native wood, of sixty-seven varieties. The work was done at odd times and leisure hours, and was completed several years ago. It has been entered for exhibition at the Centennial. The column stands four feet seven inches high, many of the pieces of wood used having an historical interest.

IN order to display at the Exhibition the habits and customs of the mysterious race known as the "Mound-Builders," formerly inhabiting the Mississippi Valley, Judge Murdock, of Macgregor, Iowa, is collecting the necessary relics, and will have constructed *fac-similes* of those wonderful mounds in Iowa, and also of the implements used by the builders.

A SECTION of one of the big trees of California, hollowed out and converted into a round house, elegantly fitted up, will form one of the minor attractions of the Centennial grounds. The section is sixteen feet long and twenty in diameter, and shows two thousand one hundred and twenty yearly rings. The height of the tree was 276 feet.

BESIDES the Main Building, the Government Building, and the Women's Building, already noticed as nearly, if not quite completed, the other buildings already on the grounds are the capacious offices for the Centennial Board of Finance, which have been ready and occupied for some time; the Judges' Pavilion is well under way; the Photographers' Building is nearly finished; the three buildings for the Commissioners of Great Britain are ready for occupation; the Swedish Building is just about finished; and the buildings for New-Jersey and Ohio are in process of construction.

BEFORE this paper reaches our readers, the wished-for Government appropriation of a million and a half will, in all probability, have been voted. The Centennial Committee of the House agreed, January 6, to report in favor of the grant, provided that the Government receive at the close of the Exhibition the same *pro rata* amount of profits as stockholders. The friends of the measure are confident that the bill will receive the overwhelming support of the House, and will pass by a close vote in the Senate.

IN the educational department of the Centennial Exhibition in Philadelphia, it is proposed to place a complete set of the works issued by the officers and alumni of Yale College. The co-operation of the graduates of Yale, and especially of those who are authors, is invited in collecting these books. At the close of the Exhibition the collection will be presented to the library of Yale College, and deposited in the "Alumni Alcove." Yale authors are requested to send their books for this purpose to Mr. B. G. Northrop, at New-Haven, Conn.

UP to the beginning of the Centennial year the following named national and other organizations had officially announced their intentions to hold their ordinary annual sessions or extraordinary convention in Philadelphia, some time during the year. Many more are expected to follow their example. How many thousands—possibly hundreds of thousands—of people these societies will call together, it is im-

possible to predict. The list comprises the Grand Lodge of the United States, I. O. O. F.; Grand Lodge of Pennsylvania, I. O. O. F.; Grand Commandery, Knights Templars; Grand Army of the Republic, Presbyterian Synod of the United States, Caledonian Club, Welsh National Eistedfodd, Patriotic Sons of America, International Regatta, Life Insurance Convention of Agents of the United States, National Board of Underwriters, State Agricultural Society, Methodist Episcopal Church National Convention, Society of Cincinnati, California Pioneer Society, American Dental Convention, Catholic Total Abstinence Union of the United States, Order of B'nai B'rith, National Alumni Association, Salesmen's and Commercial Travellers' Association, American Pomological Society, Masters' Association of the United States, Army of the Cumberland, Humboldt Manument Association, Christopher Columbus Monument Association, Board of Trade Convention, International Typographical Congress, National Rifle Association, Philadelphia County Medical Society, International Medical Congress, Old Volunteer Fire Departments, National Temperance Union, Sons of Temperance, United Tailors' Association, California Zouaves, Portland Mechanic Blues, Second Regiment Infantry National Guard, California; Fifth Maryland (regiment) Centennial Legion, and numerous grangers' organizations.

IT is proposed to erect, near the Centennial buildings, a monument, one hundred feet high, commemorative of a century's progress of our country. The design is a succession of gradually diminishing star-shaped stages, corresponding with the number of States in the Union; the original thirteen forming the base or pedestal of the rest. From the thirteenth State, and at five different intervals thereafter, the stages will be increased in height. On these stages, the statues of the Presidents will appear in their regular order, from Washington to Grant.

ARRANGEMENTS are now making for an international chess tournament at Philadelphia next year, when prizes amounting to $5000 will be competed for, the first prize being, probably, $2000. Mr. Bird brings the news that the tournament will be attended by several of the most famous European players, including Steinitz, the acknowledged head of the chess world; Blackburn, Zukertort, and Bird, from England, and Rosenthal, from Paris. Efforts will be made to render the Philadelphia tournament an event in the annals of chess-playing.

THE Post-Office Department has authorized the Postmaster at Philadelphia to invite proposals for carrying hourly mails between the Philadelphia Post-office and the office to be established on the Centennial grounds, the service to begin on the 1st of March and end on the 1st of November. Five mail-wagons will be used. They are to be prepared under the direction of the Philadelphia Postmaster, with the seal of the Department ornamentally displayed on them. They will be drawn by five horses, and be in charge of uniformed drivers.

THE applications received by the Centennial Commission for space for carriages, furniture, and household goods are so large that it has been found necessary to erect a separate structure, to be attached to the main building, for the exhibition of this special class of goods. The contract for this building has already been given out. In every case, the award of space has been much less than the amount asked for, and in some cases the reduction has been very great.

ONE of the notable events of the Centennial year will be the meeting at Independence Hall, July 2d, of distinguished literary men, to whom has been assigned the duty of preparing biographical sketches of individuals associated with the Hall during the early days of the republic. The sketches are to be deposited among the archives of the National Museum. The suggestion comes from the Committee on the Restoration of Independence Hall, and good judgment has been exercised, it is said, in the selection of the gentlemen intrusted with the work.

MR. FERGUSON, Commodore of the Schuylkill Navy, says that a very deep interest is felt in Europe, and especially in Great Britain, with regard to the Centennial regatta. He has just returned from a tour among the rowing clubs of England, where he met the leading members of a large number of amateur organizations. Though unable to give them more than an informal invitation, the response was hearty, and assurances were given of a goodly representation of rowing men from England, Ireland, and France. Ample provisions are making for the entertainment of their expected guests by the Schuylkill Navy. A full representation of the rowing clubs of the United States is counted on.

CAPT. A. L. WHITLEY, of St. Louis, is making a collection of antiquities from the Mississippi valley for the great Exhibition. He has lately obtained some interesting relics from the neighborhood of Farmington, Mo., chiefly of pottery. Among them are drinking-vessels of baked clay, gourd-shaped, with long straight necks, frequently capped with rude, but cleverly-moulded, heads of animals. One vessel represents a standing bird, the body forming a capacious chamber and the tail an auxiliary support. The vessels are of various sizes up to eight inches in diameter. The largest is ornamented by zigzag bands of blue, vermilion, and white. Besides drinking-vessels, there are shallow dishes resembling a chemist's evaporating-pan, fragments of pottery, a silicified spoon, and other objects all taken from ancient burial mounds. The Exhibition can not fail to give a great impetus to the study of prehistoric America, and it is to be hoped that other States will follow the example of Ohio, of which the State Archæological Society has taken steps to have each county fully represented by a collection of relics, models, and plans relating to the buried past.

THE strictly American product, pop-corn, will not be neglected at the Centennial, as some one has given $3000 for the privilege of selling it on the grounds. A firm of Philadelphia brewers has given $50,000 for the exclusive right to allay the thirst of beer-drinking visitors.

A ROYAL decree has been issued creating a commission charged with installing the exhibits from the Spanish colonies. The governors of Cuba, Porto Rico, and the Philippine Islands will appoint members. Spain will send a company of military engineers in uniform to superintend the shipment and arrangement of the Spanish exhibits; they will also prepare the fittings and decorations for this department of the Exhibition building.

THE President of the Italian Executive Committee will sail for Philadelphia in April, to take the direction of the Italian section of the Exhibition.

QUEEN VICTORIA will send twenty pictures to the art department of the Exhibition. The Royal Academy has decided that each Academician may send two pictures, and each Associate one. As there are forty-two of the former and twenty of the latter, a large number of pictures may be expected from the Academy. The Edinburgh and Dublin societies will doubtless help to swell the art representation of the United Kingdom.

THE Republic of Venezuela has made liberal provision for the representation of that country. President Guzman will be a visitor, and will also travel extensively in the United States.

THE Revenue Department is in something of a quandary as to its intended exhibition of the stamp system of the United States. The trouble does not arise from crooked whiskey, nor from distilled and rectified spirits of any sort, but from tobacco. For the former, empty casks can be used; but to be presentable, packages of the latter must be filled, and manufacturers' marks must appear on each package. Hereupon arises a natural competition among tobacconists who covet the gratuitous advertisement the Exhibition will afford. Until he can discover a way to obviate this difficulty, the Commissioner is compelled to decline all offers of samples. It is a nice problem, how to make the exhibition without favoring any or offending any.

THE Duke of Richmond, in accepting the resignation of Mr. Owen of the post of Chief Executive Officer of the British Commission for the American Centennial Exhibition, declares that he is himself personally directing the business of the British section with the hope of securing for it a brilliant success.

THE London *Times* states that the National Rifle Association of Great Britain have accepted the challenge of the New-York Association to take part in the match for small bores, to be held in the United States during the Centennial celebration. Sir Henry Halford has been appointed captain of the English team, and is now busily engaged in arranging the preliminaries.

THE SCIENTIFIC AMERICAN, now in its thirty-first year, enjoys the widest circulation of any weekly newspaper of the kind in the world. A new volume commenced January 1st, 1876. The contents of the SCIENTIFIC AMERICAN embrace the latest and most interesting information pertaining to the industrial, mechanical, and scientific progress of the world; descriptions, with beautiful engravings, of new inventions, new implements, new processes, and improved industries of all kinds; useful notes, recipes, suggestions, and advice, by practical writers, for workingmen and employers, in all the various arts. Every number contains sixteen large quarto pages. The year's issue contains 832 large pages, at a cost, including postage, of only $3.20 a year to the subscriber.

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## PROCEEDINGS OF SOCIETIES.

SOCIETY OF ENGINEERS. LONDON, DECEMBER, 1875.

J. H. ADAMS, President, in the chair.—Mr. F. W. Hartley read a paper on "An Improved Method of Drawing and Charging Gas-Retorts." The author first pointed out the objections to the present system of gas manufacture in distilling coals in thick layers and at high heats, with prolonged distillation. He observed that most of the recent inventions for charging and drawing retorts perpetuated the errors of that system. Mr. John West, of Maidstone, has succeeded in producing a machine which was successful in working, and was adapted for either large or small gasworks. The author then described Mr. West's invention, which consists first of a small wagon or charger, which, when filled with coal, is run into the retort, and by a very simple contrivance is made to deliver the coal in a layer about three inches thick on its return journey. The charger is carried on a trolly, which runs upon rails along the retort-house in front of the benches, the charger resting on a movable stage, capable of being adjusted to suit retorts at all elevations. The trolly is provided with a hopper, from which coals are delivered into the charger, and the trolly is propelled along the rails by a winch worked by a boy. For the new system of charging, the coal has to be reduced in size; and this is effected by means of a simple breaker, which, together with the hoist or Jacob's-ladder, is driven by the ordinary engines on the works. The hoist delivers the coals into a hopper fixed over the rails, and from which the hopper of the trolly is supplied. Mr. West uses a simple rake with which a man can clear the retort of coke at one draw. The author stated that the same kind of coals produced on the old system per retort per 24 hours from 4000 to 4300 cubic feet, and per ton 9800 cubic feet of gas, while on the new system the yield per retort was from 5300 to 5400 and per ton 10,300 cubic feet, with gas of a purer character. The retort power on the new system is stated to be increased nearly 18 per cent, the increased yield of gas per ton 5 per cent, and with Holmside coals and no cannel, gas of from 15 to 16 candle-power is produced. The author stated that with this apparatus the productive power per man would be increased more than 33 per cent, and that at London rates of wages the cost of all labor connected with gas-working would amount only to 1*s.* 9*d.* per ton, while the average in most works exceeded 2*s.* 6*d.* The saving in coals due to 5 per cent greater production of gas would be nearly four and a half per cent, and at 18*s.* per ton, gave a saving of 9½*d.* Eight per cent greater bulk of coke was sold, and that was equal to 8*d.* per ton of coal carbonized. The author concluded by observing that the practical results of the adoption of the new system in works having 14 retorts would be a yearly saving of £877 5*s.* 6*d.*, on a rental of £18,845, or equal to four and a half per cent on the rental.

MUSICAL ASSOCIATION. LONDON, DECEMBER, 1875.

R. H. M. BOSANQUET, Esq., in the chair.—Dr. W. Pole, F.R.S., read a paper on "The Graphic Method of Representing Musical Intervals." There is a natural tendency to compare the position of notes with positions in space. The word "scale" embodies the idea of the representation of intervals by spaces, and this idea has been developed in Mr. Hullah's illustration in which the scale is represented as a ladder. The principle of vibration ratios being assumed, it was proved by particular cases that the representation of intervals by such ratios leads to inconsistent results, and the representation by the logarithms of these ratios to consistent results. The employment of the logarithms leads to the division of the octave into 301 small equal parts, this number being the logarithm of the octave to three places. The diatonic scale and the ordinary tempered scale were then constructed on a diagram on which the 301 divisions had been previously laid down. The difficulties and inconsistencies which arise in the process were alluded to. Finally it was shown that the tempered scale is that on which ordinary music is really founded, but the exclusive employment of it in cases in which other modes of intonation are applicable was deprecated.

After a vote of thanks to the lecturer had been passed, with expressions of satisfaction at the lucidity with which the subject was treated, the chairman remarked that the position of those who had devoted their attention to modes of intonation other than that ordinarily employed was the subject of much misconception. As optics and other sciences attract the labors of investigators even in points of a recondite nature which frequently do not admit of practical applications, so music affords the possibility of developments of its subject-matter of an interest none the less because these generally do admit of practical applications. In the construction of the diatonic scale there appeared to be a slight divergence in the meaning ascribed by the lecturer to flats and sharps from that attributed to them in the ordinary text-books. The use of equal temperament semitones as units of interval was enforced, as being more intelligible to musicians than logarithms.

SOCIETY OF BIBLICAL ARCHÆOLOGY. LONDON, DECEMBER, 1875.

DR. S. BIRCH, President, in the chair.—The following papers were read:

1. "Notice of a very Ancient Comet, from a Chaldean Tablet," by H. Fox Talbot, F.R.S. The writer considered that the comet which formed the subject of his paper appeared in the reign of Nebuchadnezzar I., about 1150 B.C.; the following is a translation of the inscription which describes it:

"1. The star is hairy; its orb is like a shining light,
2. and it has a tail receding from it like a creeping scorpion,
3. A great star from the northern horizon
4. unto the southern horizon,
5. Extends its measure like a creeping (scorpion's tail).
6. This on the face of the tablet (was written)
7. At the time when Nebuchadnezzar had marched into the land of Elam."

2. "On Babylonian Augury by Figures and Geometrical Signs," by the Rev. A. H. Sayce, M.A. Just as astrology implies a science of astronomy, so a system of augury based upon geometrical figures implies a science of geometry. In this paper texts were given, with transliterations and translations, of two cuneiform tablets, originally, it would seem, written in the Accadian language, which furnish the augural explanations of certain geometrical figures. One of these tablets has been published by M. Lenormant, the other and longer one was now given for the first time. The author of the paper referred to the similar pseudo-science which still flourishes among the Chinese, and inferred that a superstition prevailed among the Accadians like that called *fung-shui* by the Chinese, which assumes an inherent good or bad luck in a place or situation. He also suggested that the Greek belief in the magical properties of numbers and geometrical figures, found for instance in the fragments of Philolaus and among the Therapeutæ, went back to a Babylonian origin; and determined for the first time the Assyrian ideographs for *geometrical figure, line,* and *arc.* Some of the figures were probably derived from the measurement of the sky. It is probable that the *Babylonios numeros* of Horace referred to geometry as well as to arithmetic. At the end of the paper, translations were given of the Accadian tables of square and cube roots from Senkereh, remarks made upon the sexagesimal system of the Chaldeans, and notice taken of Professor Cantor's discovery that the Assyrians had formulated $\sqrt{2}$.

3. "On the Assyrian Belief in the Immortality of the Soul, as Illustrated by the Twelfth Izdubar Tablet," by William Boscawen.

4. "On the First Sallier Papyrus," by Professor E. S. Lushington, B.A.

5. "On Two Ancient Maps of the Holy Land," by S. M. Drach, M.A., M.R.A.S.

ZOOLOGICAL SOCIETY. LONDON, DECEMBER, 1875.

GEORGE BUSK, Esq., F.R.S., in the chair.—Professor Owen, F.R.S., read the twenty-second part of his *Memoirs on the Extinct Birds of New-Zealand,* the present part describing the skeleton of *Dinornis maximus* and comparing it with that of the ostrich. Mr. J. W. Clark gave an interesting account of the eared seals of St. Paul's, Amsterdam Island, and New-Zealand, the last illustrated by specimens lent him by Dr. Hector. A communication was read from Mr. W. T. Blanford, F.R.S., proposing the name *Cervus eustephanus* for the gigantic deer of Central Asia, of which horns were obtained by the late Dr. Stoliczka. Other papers were read by Messrs. Sclater, Watson, and Caldwell, and Drs. Burmeister, Finsch, and Von Martens.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, NOVEMBER, 1875.

CRYSTALLIZATION OF LEAD.

R. ANGUS SMITH, Vice-President, in the chair.—Peter Spence, F.C.S., etc., exhibited a piece of 2 to 3 inch lead pipe in which the metal had been entirely transformed into galena, the crystallization being visible through the whole of the specimen.

The shape of the lead pipe was unaltered, showing that the lead had not been exposed to a melting heat; no increase of bulk was visible, but the pipe was so brittle as to shiver with a blow. The circumstances in which this change was effected, as nearly as can be made out, were as follows:

The pipe had been used for the conveyance of gas ammoniacal water, and was sunk under ground. It was in the vicinity of a furnace which heated the ground where it lay. It had been disused for some years, but never taken up. When the ground where it lay had to be excavated for a new erection, it was found that there had been a considerable leak of gas-water, as the ground for some space was impregnated with ammoniacal salts. About 25 per cent of the ammonia in gas-water being sulphide, and the ground being warm, a constant atmosphere of sulphide of ammonium would surround the pipe, and this seems to have been the cause of the conversion of the lead into sulphide, as only that part of the pipe which was in the vicinity of the leak was found to be transformed.

## BORAX.

THE trade in borax is likely to undergo considerable modifications in consequence of Mr. Arthur Robottom, of Birmingham, having found deposits of crude borate of soda at the bed of a dry lake in the slate range mountains. The following description appears in the *California Alta:*

"Beyond the Sierra Nevada, in the inclosed basin of North America, about 140 miles in a north eastward direction from Bakersfield, there is the bed of a dry lake, filled over an area of 15 miles long by 6 wide with saline crystals to a depth of about 6 or 8 feet. The appearance of the surrounding country clearly indicates that water once stood 60 feet deep here over a large area, the ancient beach being distinctly traceable. The most remarkable fact about this saline product is that in its middle there is a tract 5 miles long and 2 wide of common salt, while on the outside there is a deposit of borate of soda 3 feet thick, and under this a lower stratum composed of sulphate of soda and tincal mixed together from 1 to 3 feet thick. These minerals are all in crystals, the sulphate of soda and tincal forming a solid mass, almost like stone in its hardness. The borate of soda is of a dirty hue, but the salt, which lies above the level of the entire deposit, in some places to a depth of 7 feet, is white as snow. The report of natural deposit thus situated will appear very improbable to scientific men, for there is nothing to account for the separation of the salt from the borates, or for the accumulation of salt above the level of other crystalline deposits. We have Mr. Robottom for authority, and the country is open for those who wish to examine for themselves. The place can easily be found. It is known as the Borax Fields in the Slate Range, and will be examined carefully by many competent men, since the tincal—a crude borate of soda—is a valuable mineral, and can be separated at little expense from the sulphate of soda. Mr. Robottom brought samples of the minerals along, and has shipped some of the tincal to England, believing it can be obtained at less price than from Thibet, and of equally good quality. It is the most valuable borate mineral yet found on our coast, preferable for shipment to any of the borates obtained in Nevada, whereby the deposits are mainly borates of lime and soda. The California tincal can probably be used without refining for glazing fine pottery; and if so, it may drive the Thibetan tincal out of the market. Only time can determine which of California, Nevada, Thibet, Tuscany, Peru, and Chili—the principal producers of borax—can undersell the other. Tincal has not yet been found in Nevada, but it probably exists in several of the dry lake-beds in the south-eastern part of this State. The deposits of borate of lime and borate of soda are numerous."

In May of the present year the men working at the lake informed Mr. Robottom that no rain had fallen since he was there in 1874. He says the men do not work much at the under surface, for they find the crude borate of soda that lies on the surface is easily crystallized, and on exposure of the crystals to the sun after they are taken out of the vat a white powder is obtained which is preferred by some of the potters to the refined borax of the English market. The following is an analysis of a sample of this Slate Range borax:

| | |
|---|---|
| Crystallized bi-borate of soda..... | 99·75 |
| Chloride of sodium..... | 0·25 |
| | 100·00 |

For cleaning purposes, it is far more economical and possesses great advantages over common soda and washing powders. On the occasion of his last visit to the district, Mr. Robottom found a dead horse which had been left in a very thick deposit of the crude borate of soda. It had been there for more than four months, yet no offensive smell proceeded from it, although the thermometer stood at from 106° to 115° in the shade. The hair appeared to be quite firm on the skin.

THE GIRARD-AVENUE BRIDGE, PHILADELPHIA, PA.—(*See page* 49.)

## INCAUTIOUS USE OF DRUGS.

WITHIN the last few weeks we have had to report several cases in which the imprudent use of chloral, chloroform, and narcotics has been productive of fatal effects; and as there is reason to believe such a practice is very prevalent, we consider it desirable to call attention to any incident which may illustrate the danger attending the use of drugs with which the public are too familiar to suspect their possible potency. Besides chloral, chloroform, and certain preparations containing narcotics, camphor is a notable instance of this kind, and the poisonous effects of that drug were pointed out in this journal last March as having a special interest for druggists as well as for medical men.

In the last number of the *Lancet* another case of poisoning by camphor is reported, in which a camphor liniment was administered to a child by mistake in place of the proper medicine. The symptoms were exactly the same as those which have followed from an overdose of what is termed homœopathic solution of camphor—namely, convulsions and profound unconsciousness. Although camphor and its preparations are not comprised among the poisons of the Pharmacy Act schedule, it is evidently advisable that in supplying them pharmacists should give a caution as to their proper use.

The same remark also applies to the case of chloroform, more especially since it is likely to be used for the purpose of alleviating acute pain, and under such conditions it is easily conceivable that most lamentable results may ensue if any considerable quantity is handled for this purpose. The case of Mrs. Childers sufficiently illustrates the gravity of the risk incurred in this way, and it should, we think, instigate every one selling chloroform to impress upon his customers the necessity for the greatest care in using it.—*The Pharmaceutical Journal.*

## THE URINOLOGY OF GENERAL PARALYSIS.

IN the West Riding Lunatic Asylum *Reports*, Dr. Merson has a paper on "The Urinology of General Paralysis," at the end of which he thus sums up the results of his observations:

1. The quantity of urea varies above and below the average of health, being in the majority of cases considerably increased. Probably also the uric acid is increased.

2. The quantities of chlorides and phosphoric acid are notably diminished; that of sulphuric acid remains about normal.

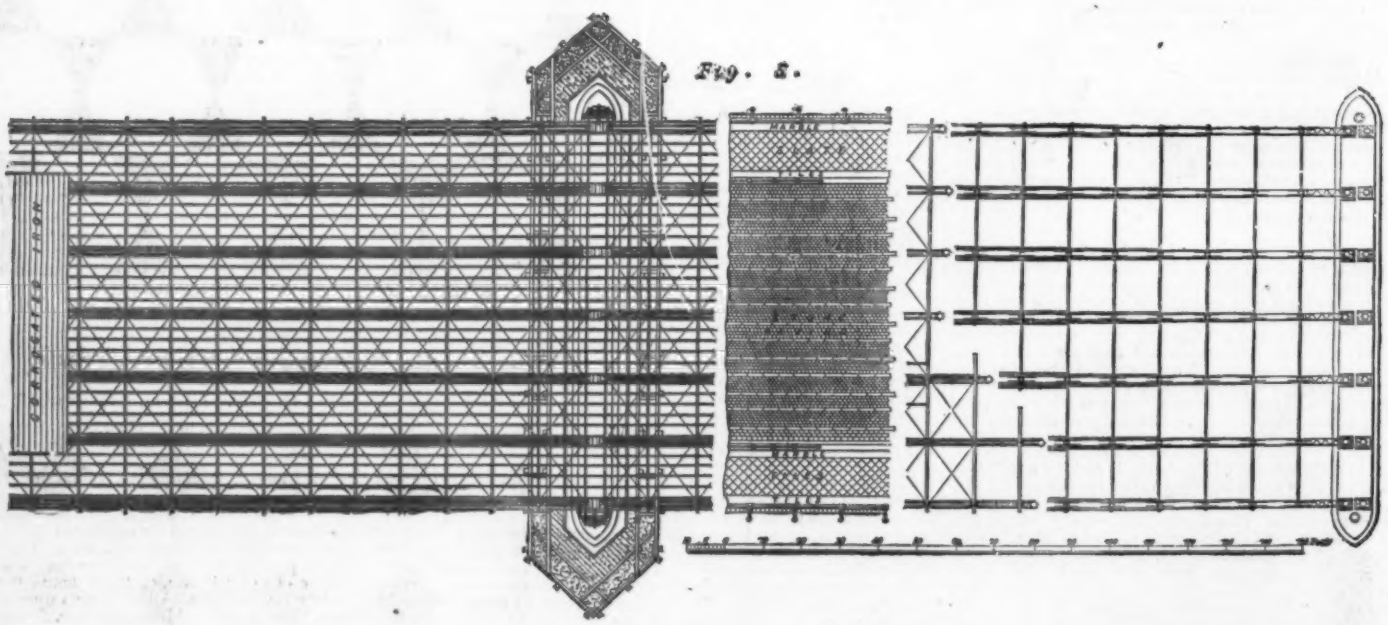
3. The specific gravity varies within wider limits than in health; but the mean does not differ materially.

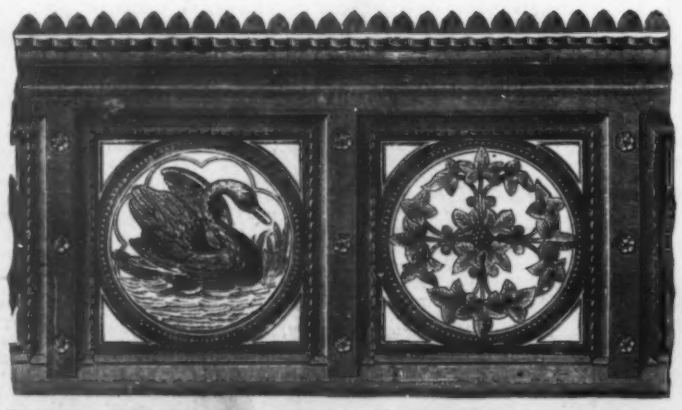
4. The absolute quantity of urine passed is slightly below the average of the healthy cases examined, but, estimated according to weight of body, the amount excreted by seventeen general paralytics was slightly in excess of that excreted by six healthy men.

5. Under the influence of Calabar bean, there is a considerable diminution in the quantity of all the solid constituents, especially the urea.

The results obtained in the three cases treated with alcohol are in favor of the view that both the quantity of urine and the amount of solid constituents are diminished under the influence of that substance.

Fig. 5.





BRONZE PANEL-WORK OF THE GIRARD-AVENUE BRIDGE.—(*See page* 49.)

Fig. 18

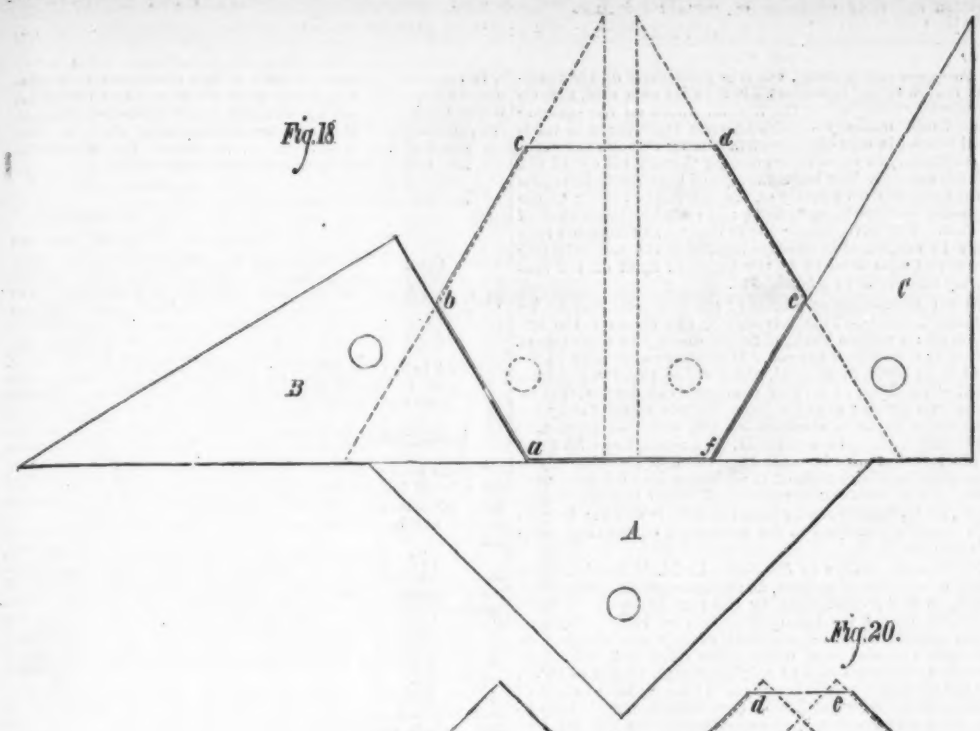



Fig. 19.

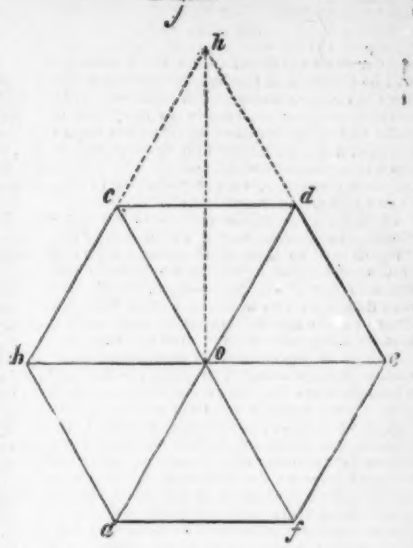



Fig. 20.

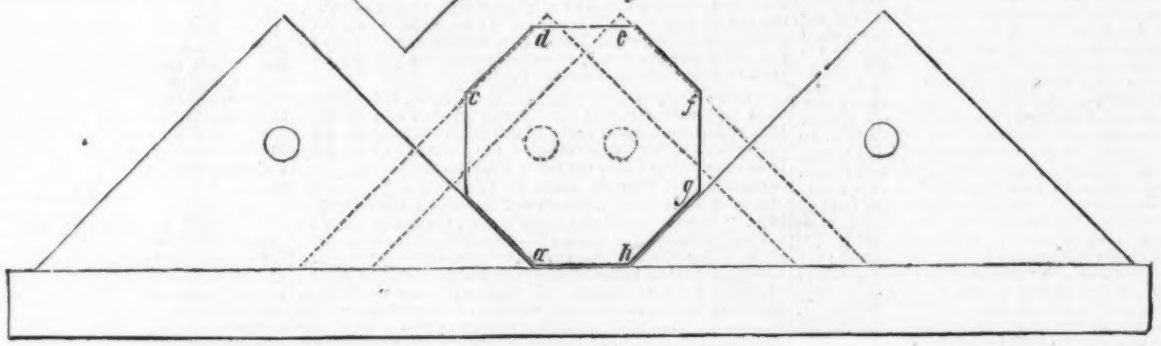



Fig. 21.

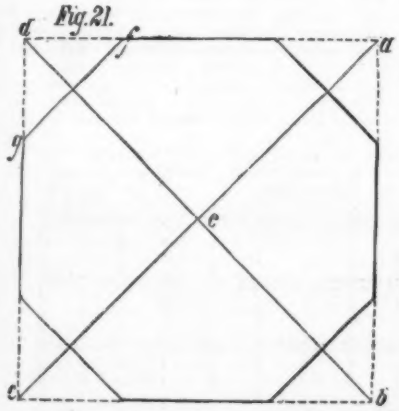



Fig. 22.

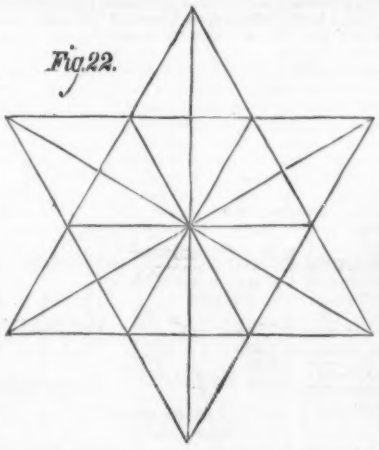


Fig. 23.

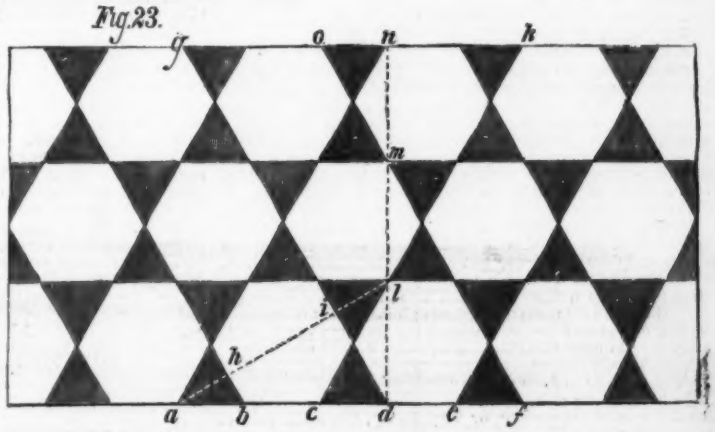



Fig. 24.

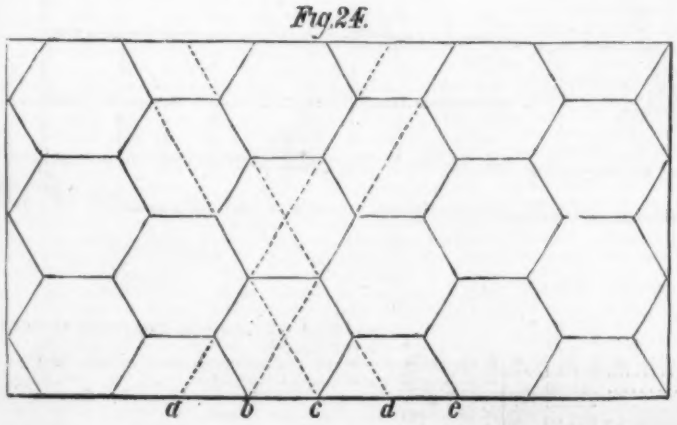
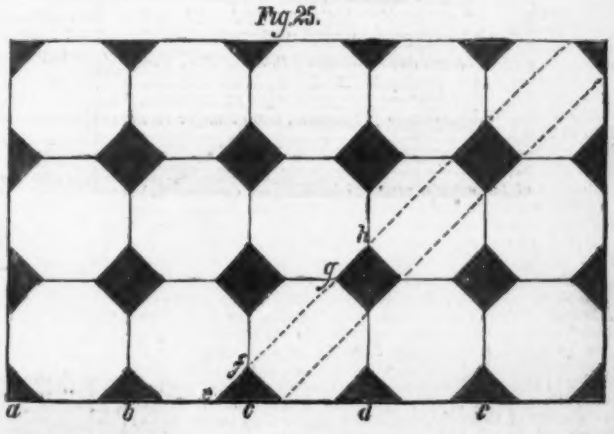



Fig. 25.




# LESSONS IN MECHANICAL DRAWING.

## LESSONS IN MECHANICAL DRAWING.

By Professor C. W. MACCORD, Stevens Institute.

(Continued from page 35.)

THE regular hexagon, Fig. 18, is bounded by the six equal sides, *a b*, *b c*, etc. If the length of the side be given, it may be constructed as in the figure, the side *a f* being drawn by the upper edge of the triangle A, *a b* by the edge of the 60° triangle in the position B, *f e* by the same triangle in the position C; then sliding it along, draw *b c* parallel to *f e*; turn it again to draw *d e* parallel to *a b*, and complete the figure by drawing *c d* parallel to *a f*, at each step measuring off the sides. By this means the hexagon is drawn without a mark to be rubbed out. But it will often be desirable to draw a hexagon of which the side is not given directly, but the diagonal, or distance "across the corners," or as it is sometimes called, the "long diameter," is known—as, for instance, *b e*. For the benefit of those unacquainted with geometry, we introduce Fig. 19, which shows that if the three diagonals be drawn, they will divide the hexagon into six equilateral triangles, so that the side *a b* is equal to *b o*, half the diagonal. And if we draw, as in Fig. 18, the sides *b c*, *d e*, and prolong them till they meet in *h*, a perpendicular to *b e*, drawn through *h*, will cut *b e* in *o*, dividing it into two equal parts, and thus giving the side of the hexagon, which may be completed as before.

The regular octagon, Fig. 20, is bounded by eight equal sides, and is drawn by means of the 45° triangle, the method of using which is sufficiently clear from the figure, without explanation.

The square may be converted into an octagon by the process shown in Fig. 21. Draw the diagonals *a c*, *b d*, which mutually bisect each other in *e*, mark off *a e* on the paper slip, and set off *a f* equal to it; draw *f g* parallel to *a c*, and it will be a side of the octagon, which may be completed by repeating this process for cutting off the other corners of the square.

By prolonging all the sides of the hexagon until they intersect, as in Fig. 22, a six-pointed star is formed. By joining the alternate corners or points of the star by lines, the reader will perceive that a hexagon similar to the first one, but of larger size, is reproduced.

Figs. 23, 24, and 25 show applications of the preceding elementary figures to designs for tessellated floors. In Fig. 23, the surface is covered with hexagonal blocks, so placed that their corners touch; but their sides, though parallel, do not coincide; thus leaving small spaces in the form of equilateral triangles, so that each hexagon is surrounded by six of these smaller blocks. Equal spaces, *a b*, *b c*, etc., are laid off, which will be the sides of the hexagons and triangles; parallel lines are then drawn through the points of division with the 60° triangle, sloping alternately to the right and the left. In order to find the distances apart of the horizontal lines, draw, say at *d*, a perpendicular to *a f*; it cuts *c k*, *f o*, and *a n* at *l m* and *n*, through which points the horizontals must pass. Or, draw through *a*, *a l*, perpendicular to *d g*; it also cuts *c k* in *l*; and *h i*, too, is equal to *d l*.

In Fig. 24, the whole surface is covered with hexagonal blocks. In drawing this, it will be found much more expeditious, as well as conducive to accuracy, to draw through each of the points, *a*, *b*, *c*, etc., whose distance from each other is equal to the side of the hexagon, with the 60° triangle, the very fine lines shown sloping each way, and afterwards to draw in more heavily the outlines of the hexagons, than to attempt the construction of each one separately.

In Fig. 25, the surface is covered with octagonal blocks and smaller square ones. The surface is first laid off in squares, whose sides, *a b*, *b c*, etc., are equal to the breadth of the octagon. These squares are then converted into octagons, as in Fig. 21; and it will be observed that, as indicated by the fine dotted lines, all the sides of the small square blocks are drawn by the 45° triangle; and, moreover, that the sides of those on opposite sides of the octagons, as *e f*, *g h*, are in the same straight line, so that it is not necessary to go through the process of measurement in order to cut off the corners of all the original large squares. As before remarked, the first division into these large squares should be done in very fine lines; the portions which form the diagonals of the small squares may then be rubbed out, and the outlines of the completed pavement then drawn in more firmly.

In executing these last designs, if the surface be too large to render the use of the two triangles convenient (and the beginner is recommended to make his drawing much larger than the cut), a ruler may be used to slide the movable triangle on, as we have shown in Fig. 20, and it will also be useful in prolonging lines if the triangles be too small.

Good practice for both hand and eye will be found in covering the surfaces of the small triangles and squares in Figs. 23 and 25 with fine parallel lines, as shown. This is to be done by simply moving the sliding triangle a small distance after drawing each line, as explained in the previous lesson. The spacing should depend for its accuracy on the eye alone, and be as uniform as possible. Thus, the lines being fine and close together, the effect at a short distance is that of an even tint. It is, in fact, line-shading; and it will be found that, if evenly done, the blocks will appear flat, as they should; but any inaccuracy in the spacing or inequality in the thickness of the lines will make the surface appear wavy and uneven. This work must not, therefore, be done hastily or carelessly, but the greatest care taken to produce the desired effect, which will add much to the beauty of the drawing.

[Les Mondes.]

## FRENCH ACADEMY OF SCIENCES.

*On New Thermic Researches on Citric Acid.* By M. Berthelot and Longuinine.—Results: 1. One molecule of citric acid dissolved ($C^{12}$ $H^8$ $O^{14}$ = 192 grammes) disengages in presence of three equivalents of soda (Na O = 31 grammes) a quantity of heat nearly three times that which one molecule of acetic acid would disengage, or 12.9 × 3 in place of 13.3. This is a characteristic property of the basic acids, of which one molecule is equivalent to three monobasic molecules. 2. The three equivalents of soda successively added disengage closely similar quantities of heat, which signifies that the formation of acid citrates by means of tribasic citrate and of a free acid does not evolve but very small quantities of heat. 3. In presence of a suitable quantity of water, the heat disengaged is not notably increased by the presence of an excess of base above three equivalents; but the heat disengaged varies, on the contrary, very sensibly if this excess of base is employed in more concentrated liquids. 4. The molecule of citric acid takes successively two different bases of the same nature, in order to form double dissolved salts. 5. Acetic acid does not displace citric acid in an appreciable manner. Citric acid displaces completely, or very nearly, the acetic acid of dissolved alkaline acetates.

*On Stripping the Leaves from the Sugar Beet.* By M. P. Duchatre.—This note inquired into the question of whether the stripping of the leaves from the sugar beet exercised an unfavorable effect on the development of the root and on the proportion of sugar produced. Actual experiment showed that this proceeding reduced the production of beets from 44,950 to 33,425 kilogrammes per hectare, and of sugar from 3428 to 2222 kilogrammes.

*On the Periodicity of Great Atmospheric Movements.* By M. St. Claire-Deville.—In this it is concluded that the extreme variations of barometric pressure in Europe, considered in connection with great displacements of the air, present, as is the case with all other meteorological phenomena, a marked tendency to reproduce themselves periodically during the year.

*On the Mechanism and the Causes of Changes of Color in the Chameleon.* By M. P. Bert.—Conclusions: 1. The colors and different shades which chameleons assume are due to the changing of place of colored corpuscles, which, according as they bury themselves under the skin so that they form an opaque background under a cerulescent layer, or as they scatter in superficial ramifications, leaving the skin its normal yellow tinge, produce green or black shades. 2. The movements of these corpuscles are governed by two orders of nerves, of which one order causes them to advance from within to the surface, and the other produces the reverse effect. In the state of maximum excitement, the corpuscles are concealed under the skin; the same is the case when a state of complete repose (sleep, death, or anæsthesia) supervenes. 3. The nerves which cause the reflux of the corpuscles under the skin have strong analogy with the vaso-constrictor nerves. Like the latter, they follow the mixed nerves of the members and the great sympathetic of the neck—they never intercross in the spinal marrow—they have, for the head, their origin at the commencement of the dorsal region, and possess a very powerful reflex centre in the medulla oblongata, the entire spinal marrow being another centre much less energetic. Finally, and also like the vaso-constrictors, these nerves are uninjured by curare and poisoned by esurine. 4. The nerves which conduct the corpuscles toward the surface are comparable to the vaso-dilatator nerves, but it is difficult to define clearly their anatomic distribution and their relations with the nerve-centres. Very probably they traverse the nervous cellules before reaching the colored corpuscles. 5. Each cerebral hemisphere governs, by the intermediation of reflex centres, the color-nerves of the two sides of the body, but acts principally on the analogous nerves to the vaso-constrictors on its own side, and on the nerves analogous to the vaso-dilatators on the opposite side. Under ordinary conditions, each hemisphere is influenced (except in case of excitement coming through the general sensibility) by excitements coming through the eye of the opposite side. 6. The luminous rays of the blue-violet region of the spectrum act directly on the contractile matter of the corpuscles to cause them to move and approach the surface of the skin. The investigator hopes that these researches may result in additional knowledge regarding the vaso-dilatator nerves, and also relative to the action of light on the sanguinary capillaries of human skin.

*On the Electrolysis of Bodies of the Aromatic Series.* By M. Goppelsroeder.—This investigator has observed the formation of an aniline black, obtained directly by oxidation of aniline by electrolytic oxygen. It possesses a metallic lustre like aniline colors in general, and gives on paper a complete black. The object of his note is to point out the fact, that by electrolysis by no means the same result is reached as by decomposition through chemical agents, and that instead of employing electrolytes separately, such a mixture with them of other bodies may be used that through the electrolytic decomposition the radicals of these bodies may act upon each other. Considerable importance is attached to these experiments, as M. Goppelsroeder believes that it will yet be possible to use electrolysis in the fabrication of coloring materials for dyes.

*On Organic Matters in Sea-Salt.* By M. E. Monier.—The purity of chloride of sodium, as regards organic matters contained, is easily determined by the permanganate. This is especially useful for the examination of brine containing putrid substances. Ten grammes of salt are dissolved in 200 cubic centimetres of water. The solution is acidulated with two or three drops of sulphuric acid, heated to 90° C, and the titrated liquor is decanted. If the reduced weight of permanganate does not exceed one milligramme, it may be concluded that the salt is pure; otherwise the product contains organic matters or traces of iodine.

*On the Construction of Lightning-rods.* By M. Saint-Edme. This note advocates the construction of rods of nickelized iron, rod and conductor being in one piece. A constant conductibility, better preservation of the point, and immunity from the effects of fire, are the advantages suggested.

*On Certain New Elements to be Discovered.* By M. Mendeleef.—In 1869 M. Mendeleef announced the following law: "The properties of simple bodies, the constitution of their combinations, as well as the properties of these last, are periodic functions of the atomic weights of the elements." This periodic law indicates the gaps which still exist in the system of known elements, and admits of predicting the properties of unknown elements as well as those of their combinations. Thus, for example, there are two gaps in the groups D III. and IV. of the fifth series, which elements yet to be discovered M. Mendeleef names eka-silicium (Es) and eka-aluminum (El). The latter, it is believed, is identical with the new element gallium recently discovered as the predicted properties, and those thus far determined are in accordance. The author now hopes that the discovery of eka-silicium Es = 72 ($Es O^2$) may be shortly made. It should be searched for in the neighborhood of arsenic and utanium.

*On the Action of Monohydrated and Trihydrated Phosphoric Acids on the Coagulation of the Blood.* By M. Oré.—Conclusions: 1. Monohydrated phosphoric acid, placed in contact with blood in an open vase, causes coagulation. Trihydrated phosphoric acid, on the contrary, is destitute of such influence. 2. Although these phenomena take place in free air, the same is not the case in the vessels, as there neither acid determines the least coagulation. 3. The direct injection of phosphoric acid in the blood is without influence on the number, color, or form of the globules; a few of the latter are, however, more elongated and even somewhat indented.

[The Maryland Farmer.]

## HOW TO MAKE FARMING PAY.

THE above is a prolific theme in agricultural papers and in some others, and is well worthy of all the consideration it gets, until the true way is clearly pointed out and fairly adopted.

The rational policy of farming is to make every acre of capital pay interest and taxes on its real value, in addition to the expense of cultivation, and leave a profit for management.

Another principle may be stated as equally true and rational: the true economy of the country is to bestow upon every acre all the labor and expense possible that can be profitably done; for the number of acres of the earth do not increase, but the number of laborers and eaters are constantly increasing; consequently, the *capacity* of the stationary acres must be enhanced—that is, practically, two blades and two bushels of grain must be made to grow where but one grew before—and a given space must be made profitably to give employment to larger numbers of workers; laborers and animals increase, but acres do not, except in instances of reclamation.

Take a five-acre field; plough and cultivate in the most common way for *wheat*—say thus:

| | |
|---|---|
| For ploughing | $10 00 |
| " harrowing twice | 2 00 |
| " sowing broadcast | 1 00 |
| " seed—8 bushels | 12 00 |
| | $25 00 |
| " interest on 5 acres of land at $50 | 17 50 |
| " taxes on same, say | 5 00 |
| " harvesting, threshing, marketing, etc., say | 15 00 |
| Total | 62 50 |

At the general average yield per acre, 11 bushels, the product from the above would be 11 × 5 = 55 bushels, at say $1.50 per bushel ..... $82 50
And say for straw ..... 10 00
$92 50
Deduct cost, as above ..... 62 50
$30 00

And we have as profit on the five acres, $30, under ordinary, and we say poor cultivation.

Now, let us see what good, thorough cultivation would give us from the same capital of five acres, $250; and we shall see how much more profitable is judicious labor than is mere capital.

In addition to once ploughing with a good team, as in the above case, let us add the expense of a boy and one horse to follow the large plough with a small plough in the same furrow, subsoiling four or five inches deeper at an expense of ..... $5 00
Add $10 an acre in manure, to be harrowed in on the surface ..... 50 00
Rolling and extra harrowing ..... 2 00
$57 00

Above the first showing; and from this treatment we will get at least 20 bushels the acre, which, at the price above, $1.50 per bushel ..... $150 00
Straw ..... 15 00
$175 00
Add to the cost $62.50 in the first estimate, the additional cost of this $57, and we have total cost ..... 122 50
Leaving profit on 5 acres ..... $52 50

This is nearly double the profit from the same 5-acre capital, effected just by applying more and better labor. Here is food for reflection, worthy every farmer's attention. The subject will be pursued in future numbers with further illustrations.

Again, by proper management, 50 bushels of oats to the acre, can be made pretty sure, with a profit of $10 to $12 per acre, requiring not more than $5 an acre more expense than is usually expended in getting 30 bushels the acre; showing that the larger yield, with all its cost, is much more profitable than the lesser; while under the former case, with its greater yield, the land is less exhausted even than in case of the lesser yield.

Now, the land being put into the rich, well-pulverized condition to bring 50 bushels of oats to the acre, would bring 300 bushels carrots, at not more than double the cost per acre of raising 50 bushels of oats, while the carrots would be worth at least four times as much as the oats to feed stock on the farm—either horses, cows, or sheep.

But, in either or all cases, greater profits will be realized by the best work, or by putting all the labor on land that can be judiciously done.

## THE CHEMISTRY OF AGRICULTURE.

PLANTS contain "carbon, water or its elements, nitrogen, phosphorus, sulphur, metallic oxides combined with phosphoric, sulphuric, and silic acids, chlorides, and alkaline bases combined with vegetable acids. From this small number of bodies are composed all those various substances which are formed in the interior of the organs of plants under the influence of the vital forces. It is very certain that those substances found developed in the tissues of plants, such as sugar, gum, volatile oils, resin, wood, etc., differ in their composition only in a slight variation in the proportions of three or four elementary principles—oxygen, hydrogen, carbon, and nitrogen—of which they are essentially constituted. Hence, it results that it is necessary for the existence of plants that they incessantly absorb water or its elements (oxygen and hydrogen), the air or its elements (oxygen, nitrogen, carbonic acid), and certain mineral substances from the soil."

We have seen that carbon forms a very large proportion of the constituents of plants, and we here give the constituents of substances in common use.

Wheat (grain), carefully dried, contains of

| | Carbon. | Hydrogen. | Oxygen. | Nitrogen. | Ashes. |
|---|---|---|---|---|---|
| Wheat | 46·1 | 5·8 | 43·4 | 2·3 | 2·4 |
| Potatoes | 44 | 5·8 | 44·7 | 1·5 | 4·0 |
| Turnips | 42·9 | 5·5 | 42·3 | 1·7 | 7·6 |
| Red-clover hay | 47·4 | 5·0 | 37·8 | 2·1 | 7·7 |

The table of these analyses is copied from Liebig's *Agricultural Chemistry*, to show how slight a variation exists in the quantity of the constituents of the different substances here given; the greatest variation is in the ashes, which are the only constituents derived solely from the soil. Compare the analysis of the wheat (grain) and clover hay, than which no two things which grow are more dissimilar in their appearance; and yet, with the exception of the ash, the difference in the proportion of their constituents is but slight.

Now, with so great similarity in the proportion of their constituents, what is the cause of the dissimilarity of the substances themselves? The answer is, that it lies in the different modes in which the carbon, oxygen, hydrogen, and nitrogen, which they contain, are combined with each other, rather than in the different amounts of each in the wheat and clover.

These elements are found to be combined, in some instances together—sometimes three and four are combined together. Plants have the power to combine, or rather these elements combine chemically under the influence of the vital action of the plants as may be required. They have the power, for example, in one place to cause them to combine in such proportions as to form starch (which is carbon, oxygen, and hydrogen), where it is required further on in the course of the sap, perhaps some vegetable acid, gum, sugar, or resin are formed. These and other substances which we find in the juices and substances of the plants are eliminated by them from the soil, the air, and the water.

Nitrogen, it is generally believed, is essential to the growth of most agricultural plants, though it is found to exist in them (as is seen in the above table) in but very small proportions, just as is the case with the mineral constituents of ashes. Ammonia is looked upon by most persons as the most active ingredient of manures, and they are valued pretty much in proportion to the quantity of ammonia existing in them. How ammonia is beneficial, or in what way plants obtain it, is an unsettled question. That it is, however, a vehicle for the supply of nitrogen is the common opinion.

It may be well to state here that ammonia is a volatile gas composed of nitrogen and hydrogen gases combined; it is found in the stores as aqua ammonia, which is the gas dissolved in water, in which it is very soluble. Ammonia is a chemical combination of nitrogen and hydrogen. It is formed during the decay of animal matter or substances containing nitrogen; water being present during the composition, its hydrogen and the nitrogen *in their nascent state*, or, in other words, at the moment they are set free, combine together and form ammonia.—*Cor. Ohio Farmer.*

[Engineering.]

## THE 81-TON GUN.

DURING the last and present months further experiments have been made at the proof-butts of Woolwich Arsenal with the 81-ton gun, in the view of testing its capacity with its present calibre of 14½ in., before the bore is enlarged. In the first series of trials the powder-charges varied from 170 to to 240 lb., and the weight of projectiles from 1258 lb. to 1260 lb. A maximum muzzle velocity of 1550 ft. was then recorded, with a total striking energy of 20,984 foot-tons, and a pressure on the powder-chamber of 29.6 tons per inch, a strain far beyond the assigned limits. The table above summarizes the practice made with the gun since the trials above made.

From these figures it will be seen that the ranges of powder charges varied from 220 lb. to 250 lb., and the weight of projectiles from 1260 lb. to 1450 lb., while the pressures recorded increased from 20.2 tons to 28 tons per square inch, the latter being given by the smallest size of powder employed, namely, 1 in. cubes. Of the series, round No. 8 shows the most favorable result, as with a 230-lb. charge of medium-sized powder, and a pressure of 24.9 tons, a muzzle velocity of 1543 ft. was obtained, and a total energy of 20,796 foot-tons, equivalent to a duty per pound of powder burnt of 90.41 tons. Comparatively small increase in striking energy was obtained by using the heavier projectile, while the pressure on the gun increased considerably. The maximum strains were produced by the smallest cubes of powder, and the largest size, whilst not throwing so much work on the gun, put less into the projectile. The powder in 1.7 in. cubes, therefore, appears in all respects best suited for the work. The advantage lay also with the use of the shot of 1260 lb., instead of the heavier projectiles, of which three rounds were fired.

THE 81-TON GUN: PARTICULARS OF EXPERIMENTAL FIRING.

| Number of Round. | Weight of Projectile. | Weight of Charge. | Size of Powder Grains. | Density of Powder. | Muzzle Velocity. | Pressure per Sq. Inch of Gun. | Foot-tons of Energy per inch of Shot's Circumference. | Total Energy in Foot-tons. | Foot-tons per Pound of Powder. |
|---|---|---|---|---|---|---|---|---|---|
| | lb. | lb. | in. cubes. | | ft. | tons. | | | |
| 1 | 1260 | 220 | 1.5 | 1.78 | 1525 | 25.8 | 445.94 | 20,313 | 92.33 |
| 2 | 1260 | 220 | 1.7 | 1.78 | 1490 | 24.6 | 386.66 | 17,612 | 80.05 |
| 3 | 1260 | 220 | 1.7 | 1.76 | 1454 | 20.2 | 405.39 | 18,465 | 80 28 |
| 4 | 1260 | 240 | 1.7 | 1.76 | 1470 | 21.0 | 414.37 | 18,874 | 78.64 |
| 5 | 1260 | 220 | 1.5 | 1.78 | 1505 | 24.1 to 26.3 | 434.33 | 19,784 | 89.93 |
| 6 | 1260 | 220 | 1.7 | 1.78 | 1502 | 23.0 | 433.59 | 19,705 | 89.57 |
| 7 | 1260 | 230 | 2 | 1.78 | 1481 | 21.7 | 420.60 | 19,157 | 87.08 |
| 8 | 1260 | 230 | 1.7 | 1.78 | 1543 | 24.9 | 456.54 | 20,796 | 90.41 |
| 9 | 1260 | 230 | 2 | 1.78 | 1498 | 23.4 | 430.30 | 19,598 | 85.22 |
| 10 | 1260 | 240 | 2 | 1.78 | 1513 | 23.0 | 438.55 | 19,905 | 83.31 |
| 11 | 1450 | 220 | 1.5 | .... | 1440 | 28.0 | 457.57 | 20,842 | 94.74 |
| 12 | 1450 | 230 | 1.7 | .... | 1414 | 25.0 | 442.23 | 20,007 | 91.35 |
| 13 | 1450 | 230 | 2 | .... | 1366 | 24.4 | 411.75 | 18,756 | 85.35 |
| 14 | 1260 | 250 | 2 | .... | 1523 | 24.8 | 444.78 | 20,259 | 81.04 |

The total amount of energy per pound of powder-charge in the 81-ton gun, as compared with that of the lighter calibres, is of interest. Thus, if we take the Woolwich and Krupp 10-in. guns—which Mr. Longdon was the other day contrasting with each other, greatly to the disadvantage of the former—we find that the figures are as follows:

| | Powder Charge. | Total Energy. | Foot-tons per Pound of Powder. |
|---|---|---|---|
| | lb. | foot-tons. | |
| 81-ton gun | 250 | 20,796 | 90.41 |
| 10-in. Woolwich gun | 70 | 5,160 | 73.70 |
| 9 " Krupp | 84 | 6,610 | 66.70 |
| 10 " " | 100 | 6,270 | 62.70 |

From the performance of the Krupp guns it would appear as though the work done by the powder diminished with increase in calibre, though, of course, so partial a comparison forbids any actual conclusion.

The 81-ton gun is, we believe, to be immediately enlarged in calibre from 14½ in. to 16 in., when a fresh and still more interesting series of trials will be commenced. So far as experience has gone, we may fairly congratulate ourselves on possessing the largest useful piece of ordnance in the world. We say useful, because no trials have been ventured upon with the monster gun made some years since by Herr Krupp. We believe, however, that some pieces of ordnance as large, if not larger, than our 81-ton gun, are now in progress in Essen, and when completed they will no doubt be as perfect representatives of steel ordnance as the 81-ton gun is of the Woolwich system. We shall look forward with interest to the trials of these large Krupp guns, for not only will they test the reliability of steel ordnance to the utmost, but ample experience of the efficiency, in the largest calibres, of the Broadwell system of breech-loading as employed by Krupp, will also be ascertained.

[The Railroad Gazette.]

## THE NEW PORTAGE VIADUCT.

(See page 60.)

WHEN the New-York and Erie Railroad was originally built from the Hudson River to Lake Erie, passing through the southern tier of counties of New-York, the importance of a connection with the principal port and city of Western New-York seems to have been much more fully appreciated by outside parties than by the directors and owners of the great railroad. While the main line was still unfinished, the Buffalo and New-York City Railroad, from Hornellsville to Attica, which now forms part of the direct line over the Erie Railway to Buffalo, was begun by an independent company, and opened for traffic about the same time as the road to Dunkirk. The country traversed by this branch road, though hilly and picturesque, offers no special difficulties to railroad-building, except the single problem of crossing the Genesee River, which runs directly across the route of a northwest railroad, and is sunk in a deep valley about 300 feet below the surrounding country. This problem was boldly solved by selecting the point where the banks were highest and the valley narrowest, and there crossing at a high elevation from bluff to bluff on the great timber viaduct designed by Mr. Seymour, which has since obtained a world-wide fame. The Genesee here flows through a remarkable chasm with rocky and precipitous sides; the width from brink to brink of precipice is just 500 feet and the depth 175 feet to the bed of the river; the grade line was fixed 60 feet above the top of the precipice, so that the greatest height of the viaduct was 235 feet, and its full length from bank to bank, 850 feet. Considering the early date at which it was done, the location of the railroad across this chasm and the construction of the viaduct must be regarded as one of the boldest and most successful feats of American railroad engineering.

The timber viaduct rested on masonry piers, which were 30 feet high in the chasm, and was built in spans of 50 feet each. Its general plan is familiar to all engineers. Its design was such that any single timber could be removed, and it was kept in repair by constantly renewing the decaying timbers. It was opened for traffic in August, 1852, and for nearly twenty-three years it continued in constant service. Early in the morning of May 6th, 1875, it took fire, and was totally destroyed. The fire was discovered about two o'clock, and the sight of this night conflagration is said to have been wonderfully grand.

It was decided almost immediately to replace it with an iron viaduct, and to make no attempt at building a temporary structure. On July 31st, 1875, the new bridge was ready for use. In the mean time, the traffic of the Buffalo Division of the Erie Railway had been sent by way of the Rochester Division to Avon, and thence by way of Batavia to Attica.

The new iron viaduct was designed by and built under the direction of Mr. George S. Morison, principal assistant engineer of the Erie Railway; the Watson Manufacturing Company, of Paterson, were the contractors for the iron-work; Messrs. Stephens & Fagan, of New-York, and Mr. John Hichler, of Buffalo, for masonry-work; the New-York and Long Island Coignet Stone Company for the repairs of the old piers; while the timber floor and other work of the kind was done by the carpenter force of the railroad company.

The masonry was so much injured by the fire that it was found necessary to rebuild the small piers on either bank, and to make extensive repairs of those in the chasm, three of which were entirely abandoned.

The new viaduct is 820 feet long over all, and 235 feet high from bed of river to rail; it contains 10 spans of 50 feet each, two of 100 feet, and one of 118 feet. It is entirely of iron, except the floor, which is of timber and designed especially to interpose an elastic cushion between the passing trains and the stiff iron structure. The trusses rest upon two post bents, each pair of adjacent bents being braced together, so as to form a skeleton tower; of these towers, there are six in all, each surmounted by a 50-feet span of bridge; the two trusses are placed 20 feet between centres, and the posts of the towers have a batter of 1 in 8, so that the principal tower measures 20 feet by 50 at the top and 70 feet by 50 at the base. Two of the towers are 200 feet high, one is 162 feet high, and the other three are less than 50 feet. The towers are built to carry the full weight of a double-track superstructure with its load, but the trusses as now erected are only for a single track. The towers are built in 25-feet sections, with horizontal struts at the top of each section and diagonal rods. The columns are of II sections, made of three plates and four angle irons, measuring 15 inches square, and laced on the fourth side; each section of column rests directly upon the one below, without the intervention of a joint-box; the connection is made by a pair of tenon plates riveted to the lower section, and a pin passes through them and the upper section, which pin serves also for the attachment of the diagonal rods; a second pin, a few inches below the joint, provides for the attachment of transverse struts and rods. Expansion is provided for at the base of the towers by placing the south side of each tower on rollers, while the north side is secured by dowel-pins; expansion in the direction of the length is provided for by placing one end of every second span on rollers, while a slotted link limits the amount of motion to that actually required to provide for changes of temperature. The trusses are of the Pratt pattern and of simple design. The timber-floor is formed of oak beams, 8 x 14 inches, placed only 10 inches apart, and resting directly upon the upper chords of the trusses; they are stiffened by a 9 x 9 inch ribbon on each side of the track to which every beam is bolted. A plain wooden railing and foot-walk complete the floor.

The towers were raised with no other falsework than a movable frame, which was successively transferred from the top of one section to that next above it, and formed a stiff scaffold, to which were attached the blocks and lines used in raising the iron. To raise the long span trusses, light temporary trusses were built with wooden upper chords, sprung apart at the centre into a bow shape, so as to require no lateral bracing, and with V-shaped posts. These trusses were put together in the bottom of the chasm, and raised by block and falls to the upper section of the tower, where a scaffold was erected on them, and the permanent truss was at once put together. All the iron for the main towers was lowered into the chasm, and then raised into position, an arrangement which required a great deal of handling of material, but enabled the work to proceed with great speed; the superstructure was run out from each and over the top of the viaduct.

The total weight of iron in the viaduct is 1,310,000 pounds, while 18,300 feet B. M. of timber and 28,000 pounds of iron in bolts, washers, etc., were used in the floor. The entire cost of the structure above the masonry was about $95,000.

## THE TEA-TREE.

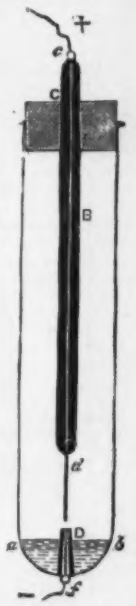
THE beautiful coral-like fruit with which the so-called tea-tree (*Lycium barbarum*) has been loaded in some localities this autumn, has suggested the inquiry whether it had ever been turned to any useful purpose. So far as we (*Gardeners' Chronicle*) know, no experiments have been made in this direction, but it is at least probable that it would be worth while to institute a few judicious investigations into the matter, especially as we learn from Dr. Brandis that the fruit of allied species is eaten in India. The berries of *L. europæum* are eaten in the plain districts of the Punjab, Sindh, and Guzerat; and camels and goats feed on the branches.

## NEW FORM OF TUBE FOR OBSERVING THE SPECTRA OF SOLUTIONS.*

WE have the honor of presenting to the Academy an eminently useful spectro-electric tube;† it realizes, in fact, a certain number of advantages, which are as follows:

1. Constancy of spark permitting prolonged observation of spectra. 2. Suppression of the meniscus, and consequently of the absorption which it produces by partly concealing the spark. 3. Electrodes inclosed in a special tube, which preserves the solution from contact with impurities. 4. Possibility of collecting entirely the substance examined. 5. Possibility of arranging a series of spectroscopic tubes, inclosing solutions of the various bodies, thus permitting rapid demonstrations and comparisons.

The closed tube A of eleven centimetres in height, and 1¼ centimetres in diameter, is traversed by a lower platinum electrode *f*; in the mouth of A is fixed a cork stopper C, pierced by an orifice through which passes a capillary tube B. B is traversed by a platinum wire *c d*, terminated at the upper end by a ring, and at the lower end by a point *d*, opposite *f*. *d* and *f* are the electrodes. The important part of the apparatus is a small capillary tube, slightly conical, one centimetre in height, movable, and which covers the lower electrode *f*, topping it by ½ millimetre.




A, Tube into which the liquid to be analyzed is poured. B, Capillary tube in which is fixed the platinum wire *c d*, which forms the upper electrode. C, Cork stopper closing the tube A; it supports B, and permits its being moved with little friction. D, Small capillary tube, slightly conical, covering the lower electrode *f*. *d*, Upper electrode. *f*, Lower electrode. *a b*, Level of liquid.

To work the apparatus, pour into the tube A the solution to be examined, taking care that the electrode *f* and the tube D are only immersed to half their height. Let *a b* be the level of the liquid; capillary force determines the ascent as far as the point D, on which is formed an immovable drop which is vaporized when an induction current is put on by *c* and *f*. The observations may then continue a very long time without intermission, allowing the spectra to be observed and drawn with the greatest ease.

This very simple apparatus has rendered us so great service in the course of our investigations, that we can not too strongly recommend its use to chemists engaged in spectral analysis. Nevertheless, in some cases, as, for example, when it is desired to observe the spectrum of ferric solutions, it is preferable to employ the original tube; for the flow of the liquid causes solid particles to be given off, which tend to become fixed in the electrode.

[The Engineering and Mining Journal.]

## NEW PUMPING-ENGINES.

THE new pumping-engines, designed for the Covington, Ky., Water-Works, by Mr. Alfred E. Watkins, M. E., are somewhat novel in design, and the following description of them, compiled from the specifications, will convey an idea of their general character.

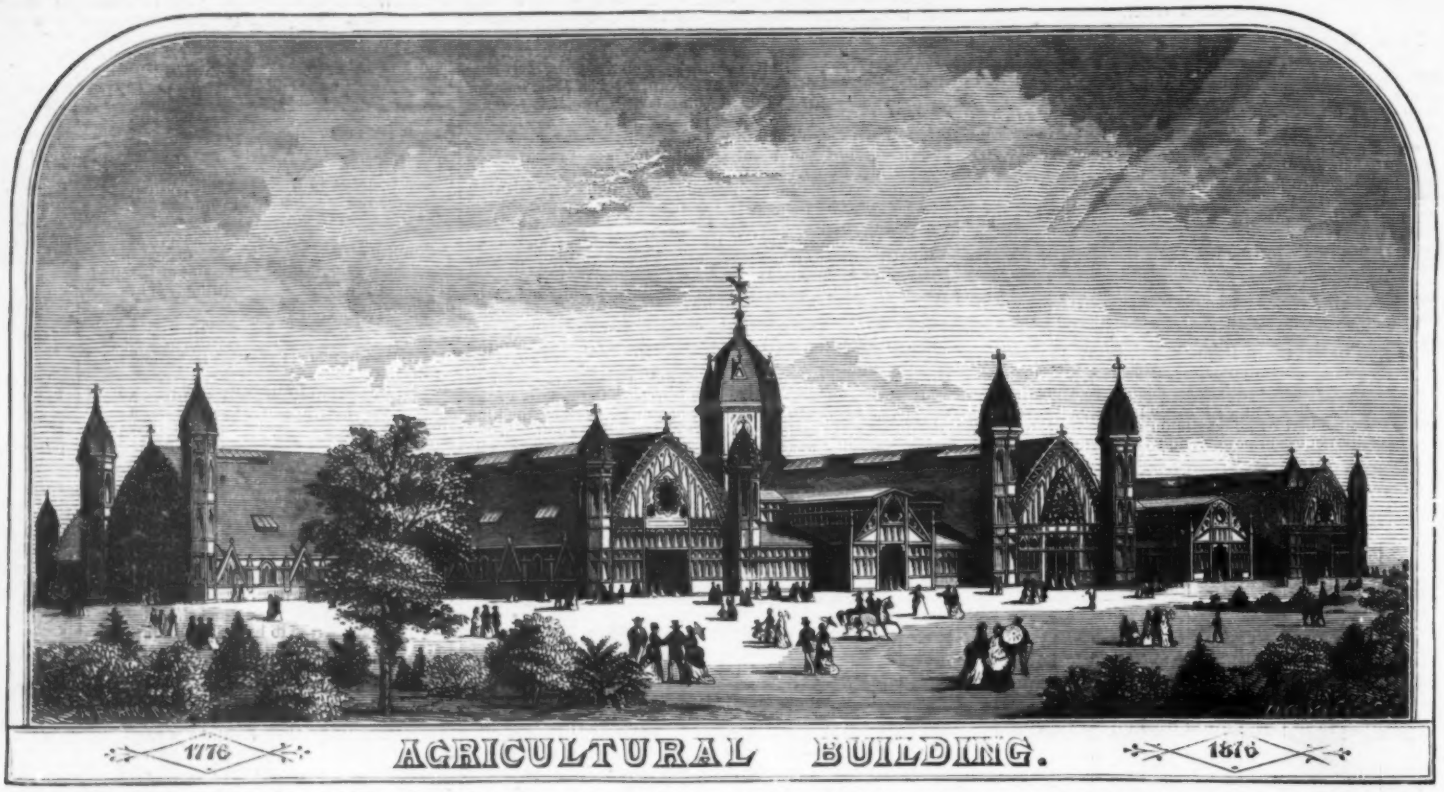
The pumps have a minimum capacity of a million and a half gallons per 24 hours, and the engines have sufficient power to elevate the water 328 feet from low water in the Ohio to the level of a proposed reservoir within half a mile of the pump-house. Till this reservoir is built, the engines will do fire duty by forcing direct into the street-mains. A boiler-iron well-curb, 8 feet 6 inches internal diameter and 5-16 inch thick, is sunk to a depth of 51 feet below the pump-house floor. The sheets are calked to prevent external leakage, and strengthened against being forced out of shape while being lowered down, by a 2½ x 2½ angle-iron riveted centrally to each sheet. Within a few inches from bottom of curb is riveted a cast-iron ring, bored out to receive a heavy plate upon which the pumps and valve-boxes rest. The pumps (two in number) are 12 inch. diameter by 40 inch. stroke, and are arranged one on each side of a pair of valve-boxes, to which they are secured. The valve-boxes are connected at the top by a ⅄ pipe, upon which rests a wrought-iron air-chamber 44 inches diameter by 12 feet high. The force-pipe extends out from top of the air-chamber and connects with the street-mains. Across the top of the curb and securely riveted thereto is a strongly braced, circular, cast-iron bed-plate, surrounded by an ogee moulding. Through this plate depend the two steam-cylinders which are secured by their top flanges, their lower ends hanging freely into the curb; the top-heads are cased with polished, moulded casings. The piston-rods extend through both cylinder-heads, the lower ends being extended by a wrought-iron pipe, 4½ inches diameter, passing through guides bushed with wood to the pump piston-rods below. The upper ends are keyed to cross-heads, which, by means of connecting-rods and cranks, transmit motion to a fly-wheel revolving on a pair of gallows-frames extending across the bed-plate, and firmly secured thereto. The engines are connected at right angles to each other. The cylinders are 22 inch. diameter by 40 inch. stroke. The valves are of the ordinary gridiron type, having a pair of cut-off valves, sliding on their backs, operated by right and left hand-screws, all of which are driven directly from fly-wheel shafts without intervention of rockers. The steam-chest stuffing-boxes extend above bed-plate for convenience when packing. The bed-plate is trimmed off with five polished hand-wheel columns, arranged to operate the two suction-valves, cylinder-cocks, steam and cut-off valves. Each engine and pump is so arranged that it may be operated independent of its neighbor.

In conclusion, we would say that the extreme simplicity of detail, as exhibited above the floor-line, gives a fine appearance to the machine, while the rigidity of its component parts enabled it to start off (as a local paper has it) like a sewing-machine. At its first trial, running light, it was worked up to 15 and down to 3 revolutions per minute.

THE Williamsburg Yacht Club have decided to go to Philadelphia during the Centennial Exhibition for two months with the yacht Victoress, which will be properly fitted and supplied for the trip.

* Paper read at the Paris Academy of Sciences, October 30th, by MM. Delachanal and Mermet. *Comptes Rendus*, t. lxxxi. No. 17, p. 708.

† See the description of the original apparatus in the "Annales de Chimie et de Physique," 5e series, t. iii., 1874.




THE INTERNATIONAL EXHIBITION OF 1876.—ELEVATION SHOWING THE AGRICULTURAL BUILDING.

## THE AGRICULTURAL BUILDING OF THE INTERNATIONAL EXHIBITION.

IN continuance of our series of illustrations of the International Exhibition at Fairmount Park, Philadelphia, we give herewith views in elevation and plan of the Agricultural Building.

This structure will stand north of the Horticultural Building, and on the eastern side of Belmont Avenue. Its precise position will be seen by reference to the map of the grounds published in our Supplement, No. 1. This structure will illustrate a novel combination of materials. Its materials are wood and glass. It consists of a long nave crossed by three transepts, both nave and transept being composed of Howe truss arches of a Gothic form. The nave is 826 feet in length by 100 feet in width, with a height of 75 feet from the floor to the point of the arch. The central transept is of the same height, and a breadth of 100 feet; the two end transepts 70 feet high and 80 feet wide.

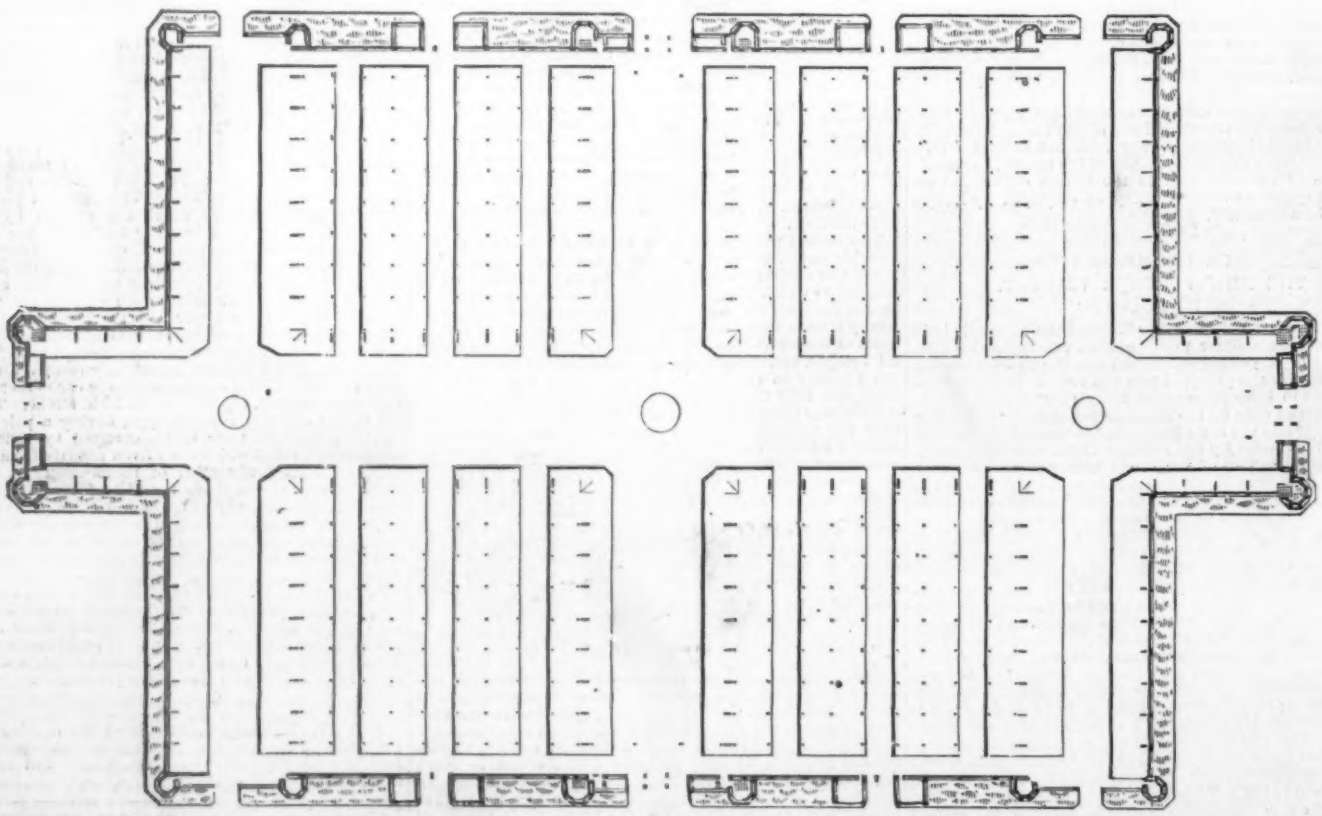
The four courts inclosed between the nave and transepts, and also the four spaces at the corners of the building, having the nave and end transepts for two of their sides, will be roofed and afford a large area for exhibits. Thus the ground plan of the building will be a parallelogram of 540 by 820 feet, covering a space of nearly ten acres. In its immediate vicinity will be the stock-yards for the exhibition of horses, cattle, sheep, swine, poultry, etc.

### GROUND PLAN OF THE AGRICULTURAL BUILDING.

The arrangement of the ground plan shows four main avenues, one running north and south through the centre of the building, 820 feet long by 70 wide. The three remaining avenues run east and west, one through the centre of the building and one at each end of it, distant from said ends 25 feet; the former is 540 feet long by 60 wide, and the two latter 540 feet long by 30 wide. The building is divided by the above avenues into sections, and each section has aisles 13 feet wide by 197 feet long, extending through it and opening into the main north and south avenue at one end, and into the side passage-ways at the other. The four main avenues, with the aisles, form a most admirable arrangement by which the exhibitor can display and the visitor observe the various articles exhibited. There are, besides this, spaces at the ends and sides of the building, which can be used either for wall or floor exhibits. The main north and south avenue, being 70 feet wide, is specially adapted for the display of all varieties of small fruits, etc., etc. The rules and directions for the government of the Agricultural Bureau of the Exhibition will be found on the second page of cover.

## PROGRESSIVE MUSCULAR ATROPHY.

AT a meeting of a medical society in Manchester, lately, Dr. Bramwell showed two cases of this strange disease. The first was a pitman, aged twenty-two. Eighteen months ago he first noticed a weakness in his left hand. A pail of water which he was in the habit of carrying slipped every now and again out of his hand. "Cold made the fingers curl up." The right hand became affected a year ago. The patient's general health was very good. The muscles of the body generally were well developed; the biceps remarkably so. The muscles of the left thumb and hand were completely atrophied. The muscles of the right hand were affected, though to a less degree. The muscles of the left forearm were beginning to be atrophied. The second patient was also a pitman. He was twenty-eight years of age. He was admitted to the Newcastle Infirmary some weeks ago, under Dr. Embleton, by whose kind permission Dr. Bramwell was enabled to exhibit the patient. In this case the disease was in a very advanced stage. The man was unable to rise from his seat. He could not raise his hand to his head. The muscles of the arms and thighs were most affected. The disease had commenced only seven months ago, in the ball of the left thumb. It had rapidly spread to other muscles. The atrophied muscles still responded to galvanism. This patient stated that when sitting he felt perfectly well. Vision was somewhat dim. On ophthalmoscopic examination, commencing gray atrophy was seen to be present. This fact favored the nervous origin of the disease.



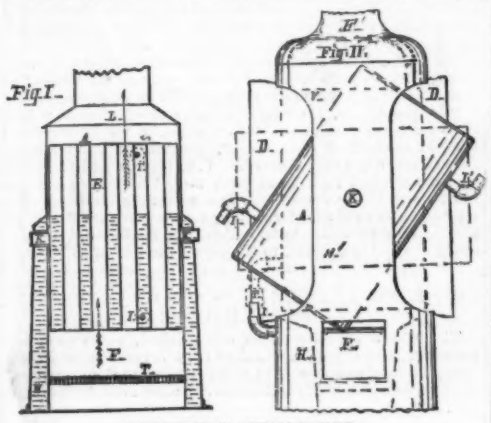
THE INTERNATIONAL EXHIBITION OF 1876.—GROUND PLAN OF THE AGRICULTURAL BUILDING.

## REVERSIBLE STEAM-BOILER.

By S. S. VAIL, Keokuk, Iowa.

FIGURE I. vertical section of boiler, Fig. II. an elevation.

The boiler A has upright tubes E, with fire-box F below, and an auxiliary water-heating chamber, H, in its furnace-frame H′. The invention consists in hanging the boiler on trunnions K in its centre, so that it can be reversed, and connecting this with the stationary frame, H′, and water-heating chamber H, by pipes I, made so as to be readily detachable for reversing, and which hold the boiler rigid with its supporting-frame H′ when in use. This is to reverse the boiler when the lower end becomes encrusted with scale, to bring down clean surfaces from the steam-space, and to turn the encrusted parts up to the action of the steam to loosen the crust. Also, for turning the boiler down on its side to clean the flues, and to repair them, and calk their joints, and for washing out the boiler by swinging it back and forth. The two ends of the boiler are alike, and the trunnions K are in the centre, so the boiler may be reversed without changing




REVERSIBLE STEAM-BOILER.

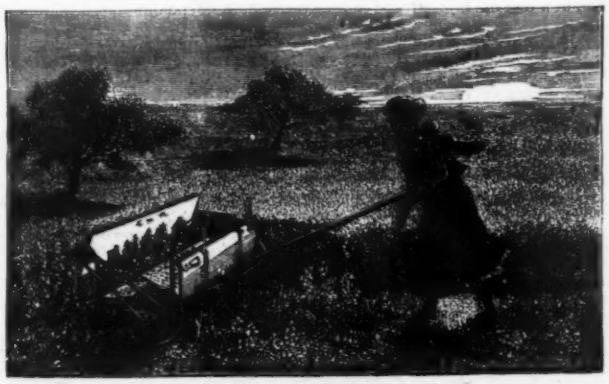
its relations by removing the connections. The connecting-pipe I is for the ingress of water, and the pipe I′, egress of steam. They are attached directly to the boiler A at the ends, though I may connect through the trunnions in the ordinary way, if desired. These connecting-pipes I I′ serve for holding the boiler rigid to its supporting-frame H′ when in use. There may be a pipe-connection on each side at each end, or only on one side, as desired. And additional means may be used to strengthen the rigidity while in use, the boiler being reversible on its trunnions.

The water enters first the auxiliary heating-chamber H, and then passes into the boiler A by pipe I. The upper part of the boiler forms the steam-space; but an additional steam-space may be formed in frame H′ above the boiler at L, to further heat the steam by means of the waste smoke escaping, which chamber may be connected by steam-pipe I′.

The trunnions K are supported by bearings in frame H′. This frame has fire-box F below the boiler, with stationary water-heating chamber H surrounding it, and its upper part forms the boiler-cover, and smoke-outlet F′ suitably supporting and inclosing the whole. It is cut away at the two sides to let the boiler ends pass in reversing it on its trunnions, as shown in position by full and dotted lines in Fig. II. These openings have shutters D D hinged at the sides and opening in the centre, so as readily to be opened or closed.

## APPARATUS FOR DESTROYING POTATO-BEETLES.

M. BADOUA, of Claira, France, has designed the apparatus figured in our engraving. It consists of a trough mounted on two light wheels, the pinion of one of which is bound by a strap to the axis of an inclined board, or movable paddle-door, which turns on itself as the machine advances, and bending the potato-stalks without breaking them, shakes them gently over the trough. These slight strokes thus impinged upon the stalks cause the larvæ and adults to fall into the trough, especially if the operation is carried on in the early morning when they are still benumbed on the leaves



APPARATUS FOR DESTROYING POTATO-BEETLES.

and stalks by the coolness of the night. When the trough is full, the insects are withdrawn, and are either burned with straw or scalded with boiling water, or buried in the ground. —*Maurice Girard, La Nature.*

## NEW APPARATUS FOR PRESERVING BEER.

By LOUIS WEINMAR, Buffalo, N. Y.

AN apparatus for charging beer, ale, and similar liquids with carbonic acid gas, so as to prevent the same from becoming stale and unpalatable by the escape of the gas originally contained in such liquids.

Figure 1, elevation; Fig. 2, vertical section.

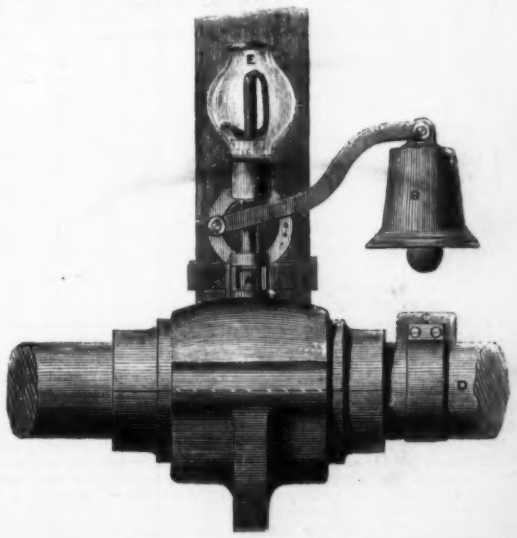
A, cylindrical outer vessel or acid-reservoir; B, the inner generating-vessel, open at bottom, closed at top; *c*, perforated diaphragm in the inner vessel B; D, washing or purifying chamber arranged in the upper portion of the vessel B, connected with D by a bent pipe *e*; *f* is the gas-discharge pipe, connecting the washing-vessel with the bent *g*, to be driven into the cask containing the malt liquor; *h* and *i*, two vents in A, one for admitting air, the other to permit the escape of air. D is charged with water or, preferably, a solution of bicarbonate of soda, and the generating-vessel with a suitable quantity of marble-dust or chips placed upon the perforated diaphragm *c*. The outer vessel A is charged with muriatic acid, which rises above the marble-dust, and generates carbonic acid gas, which accumulates in the vessel B, and passes thence through the pipe *e* to the washing-vessel D, where it rises through the liquid contained therein, and escapes by the pipe *f*. When no beer is drawn from the cask, nor any gas absorbed by the beer, the gas accumulates in the vessel B, and gradually expels the muriatic acid from the vessel B through the perforations *b*, so as to withdraw the acid from the marble-dust, whereby the generation of gas is stopped until an escape for the accumulated gas is provided by drawing beer from the cask, or by the gradual absorption of the gas by the beer, when the acid will again rise in the vessel B to its former level, and the generation of gas recommence. When the muriatic acid is expelled from the vessel B, as above described, it rises in the outer vessel A, expelling the air therefrom through the vent *i*, while, when the acid is permitted to rise in the vessel B, the outer air enters the vessel A through the vent *h*.

It will be seen from the foregoing that the outer vessel A is practically open at the top, as the vents *h* and *i* permit the free ingress and escape of the air to and from the vessel A. The function of the vents *h* and *i* is to prevent the muriatic acid contained in the vessel A from exhaling the objectionable fumes which it would if the vessel A was partially or entirely uncovered.

## LUBRICATOR ALARM-SIGNAL.

ALTHOUGH most people, whether practically acquainted with the working of machinery or not, will easily understand that inconvenience and even danger must follow the overheating of its movable parts from friction, engineers well know how annoying and dangerous the heating of bearings may become. As in other matters, "great events from trifling causes spring," and the overheating of a bearing, by occasioning the breaking of the crank-shaft of a steamer, or even necessitating a short delay from the stoppage of the machinery, on a lee shore, may eventuate in the loss of many lives. From the same cause, much loss, both to mill-owners and factory operatives, may be occasioned. Not only do the stoppages of machinery involve the forced idleness of hundreds of workmen, and a corresponding loss to their employers, but there are several instances of large factories having been burnt from overheated bearings, and it is said that fires from this cause are increasing in frequency. The danger arising in this way may be estimated, when it is considered that the lubricants employed are often mineral oils which ignite at a comparatively low temperature; and in cotton factories there is always more or less light fluff adhering to the machinery in the neighborhood of the bearings, whilst the bearings themselves being generally out of sight, the attendant can only tell that the lubricators are acting by the condition of his oil-cups, which may remain full when that is not the case through an obstruction in the tube which conveys the lubricator to the machinery, and he may thus be kept in ignorance of the danger until the heating gets beyond control. In several instances in the present year, large manufactories have been burnt in this way. One notable fire originated in a driving-shaft becoming overheated by friction on the bearer. The oil ignited, the fluffy matter collected on the machinery went off like a train of gunpowder, and in two or three minutes the room was in flames. Within about two months, in fact, five large factories were thus destroyed, with a considerable loss of life, and at a cost of about £200,000, besides loss of labor and profits.

Alley's bearing feeler and lubricator not only tests the condition of the brass bearing, but when heating has been caused by the obstruction of the ordinary lubricator, furnishes a temporary relief while giving the alarm. The mode of action is as follows: The bell B is held in an elevated position by the composition plug A. If the supply of oil ceases from any cause, the bearing heats and melts the plug. The bell B, thus losing its support, drops into gear with kicker C on the shaft D, rings, and continues to ring until the bearing is cooled down, and the plug renewed. These plugs are formed of hard fatty matter, which melts at 130° Fah., the most inflammable lubricant not taking fire until the temperature of the metal reaches 300° Fah. As has been mentioned, the substance of the plug running into the bearings prevents the evil from increasing before steps can be taken to reduce the heat. In brief, the bearings are felt continuously at the right spot, and the point of alarm is fixed when the heating can be easily arrested, the feeler itself taking the first step toward that end. Finally, this is done automatically by an apparatus which is simple and not liable to get out of order, thus reducing risks from carelessness to a minimum.—*Iron.*



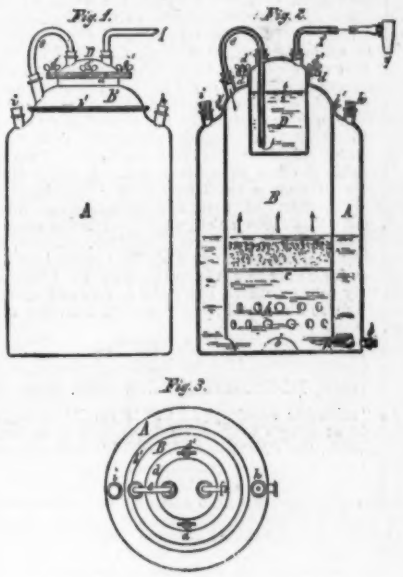

LUBRICATOR ALARM-SIGNAL.

[The Academy.]

## PHYSIOLOGY.

EXPERIMENTAL ARREST OF A ZYMOTIC PROCESS IN THE LIVING ORGANISM.—It was accidentally found by Luchsinger (*Pflüger's Archiv*, xi. 10) that the injection of a watery solution of glycerine into the subcutaneous areolar tissue of a cat or rabbit was invariably followed by an abundant discharge of the coloring-matter of the blood through the kidneys. Inasmuch as the dissolution of red corpuscles in the circulating fluid is always attended by the liberation of a ferment capable of transforming glycogen into sugar, the latter substance was looked for in the urine. Not a trace of it could be detected. Subsequent experiments showed that its absence was not due to any lack of glycogen in the liver. The possibility next suggested itself that the glycerine might have checked the characteristic activity of the ferment. The following experimental results seem to show that glycerine is really endowed with some such power. It is well known that glycosuria may be excited at will in the rabbit, by injuring a particular spot in the floor of the fourth ventricle, or by putting the animal under the influence of curare. Now it was found that the occurrence of this artificial glycosuria could always be prevented by the previous injection of a sufficient quantity of glycerine under the skin. Moreover the transformation of hepatic glycogen into sugar, which usually occurs soon after death, may be checked by injecting glycerine subcutaneously during life.

PHYSIOLOGICAL ACTION OF A NEW ALKALOID.—By acting on diethyloxamide with phosphorus pentachloride, Wallach has succeeded in the synthesis of an alkaloid to which he has given the name of chloroxalethylin. The action of this new compound has been investigated by Binz (*Archiv für exp. Pathologie und Pharmakologie*, October 22, 1875). It exerts a decidedly depressing influence on the cerebral and spinal centres of the frog; the peripheral nerves are affected in the same way, but at a later period. In warm-blooded animals, it lowers the temperature of the body, but does not produce narcotic effects in any mammal except the cat. It resembles




NEW APPARATUS FOR PRESERVING BEER.

atropia in paralyzing the inhibitory apparatus of the heart; so that, when a frog has been put under its influence, neither electrical stimulation of the *sinus venosus*, nor the injection of muscarin, avails to stop the ventricular contractions. When a sufficient dose had been administered to a rabbit, irritation of the vagus was no longer followed by its usual effect. Though resembling atropia in its action on the heart, the new alkaloid differs from it in not causing dilatation of the pupil when instilled into the eye. Both in its positive and its negative properties, therefore, it seems to be more nearly allied to tropin, a derivative of atropia.

ON THE CORNEITIS WHICH FOLLOWS INTRACRANIAL DIVISION OF THE TRIGEMINUS.—The curious effect on the nutrition of the eyeball, produced by section of the fifth nerve within the skull, was first pointed out by Magendie in 1824. Since that time, his experiments have often been repeated and varied, with the object of making out, if possible, whether the corneal changes should be ascribed to lesion of certain "trophic" fibres supposed to run in the branches of the trigeminus, or simply to the external irritation and injury from which the eyeball, by reason of its insensibility, is no longer shielded by its ordinary safeguards. Senftleben believes himself to have set the question finally at rest (*Virchow's Archiv*, October 12, 1875). His conclusions are, in the main, identical with those at which Snellen formerly arrived; but they are supported by a stronger body of more varied evidence. The primary change in the cornea he finds to be a simple necrosis of very limited dimensions, caused by violence inflicted on the insensible eyeball. This circumscribed necrosis is followed, in accordance with well-known pathological laws, by a secondary inflammation, setting out from the margin of the cornea, and advancing towards its centre. These changes are wholly independent of any "trophic" influences conveyed through the trigeminus; indeed, there is no reason to think that the trunk of this nerve contains any "trophic" fibres. Sinitzin's statement, that the occurrence of corneitis after division of the fifth nerve may be prevented by the simultaneous extirpation of the superior cervical ganglion of the sympathetic, was found to be entirely erroneous.

ON SOME POINTS CONNECTED WITH THE FUNCTION OF THE KIDNEYS.—Grützner describes a set of experiments intended to throw light on the connection between the arterial blood-pressure and the quantity of urine secreted in a given time (*Pflüger's Archiv*, xi. 6 and 7). He brings evidence to show that the relation between them is less simple than Ludwig originally supposed it to be. A great fall of blood-pressure such as is caused by division of the spinal cord in the cervical region, or by poisoning with curare and chloral hydrate, undoubtedly arrests the renal secretion; but the latter may be re-established, without any proportionate rise of blood-pressure, by injecting urea or sodic nitrate into a vein. On the other hand, anuria may likewise follow an increase of blood-pressure, caused by intermittent electrical stimulation of the medulla oblongata, or by the effect of an accumulation of carbonic acid in the blood upon the vaso-motor centre. The mechanism of this form of suppression is simple enough. The transudation of water through the walls of the Malpighian capillaries is proportionate to the blood-pressure in their interior. But the general spasm of the arterial system caused by either of the two methods described above affects the afferent vessels of the tufts in common with all other arterioles, and hinders the blood in their interior from taking part in the general rise of tension. If the experiment be repeated after previous section of the vaso-motor nerves going to one kidney, we find secretion proceeding actively in this organ, while it is arrested in the opposite one. Must we then conclude that the flow of urinary water depends simply on the degree of tension subsisting in the Malpighian tufts? The diuretic effects of urea and sodic nitrate, alluded to above, prove that these substances exert some more immediate influence on the secretory function. Indeed, diuretic agents may be grouped in two divisions: some, like digitalis, operating indirectly, by the variations in blood-pressure which they cause; others, like sodic nitrate and urea, by exercising a more direct and special influence on the secreting tissue.

[The Academy.]

## MICROSCOPICAL NOTES.

AT a "scientific evening" of the Royal Microscopical Society, held at King's College on November 24th, Mr. H. C. Sorby, F.R.S., the President, exhibited his new apparatus for exactly determining the position of absorption bands seen with the microspectroscope. It was found very easy to bring the bands of the test scales to positions coinciding with those of the bands to be tested. Starting the apparatus at the zero of its scale, the amount of rotation required to bring any band into the right position was easily read off, and on reference to a table which Mr. Sorby has calculated and published in the *Monthly Microscopical Journal* for December, the wave length in millionths of a millimetre can be ascertained by simple inspection. The figures and explanations given in the above-mentioned journal will enable any skilful optician to make the instrument.

At the ordinary monthly meeting of the Royal Microscopical Society, December 1st, Professor Bennett directed attention to some peculiar bodies he found in Drosera, Pinguicula, and other insectivorous plants. These bodies are below the cuticle, and have a glandular aspect. They exhibit some cross markings, which give them a superficial resemblance to the external glands of Coleus, described and figured by Mr. Slack (*M. M. J.*, May, 1872), but they are not, as those are, epidermic structures of the nature of glandular hairs. They have evidently a different function as well as a different position, and Professor Bennett thinks it possible they are organs of digestion. The paper was illustrated by drawings and by the exhibition of the actual objects under the microscope.

Dr. Lawson showed an apparatus, devised by M. Hayem and made by Nachet, to facilitate the estimation of the number of red corpuscles in a given quantity of blood. It consisted in a cavity of definite size, cut in a glass slide. Into this, blood, diluted with a known quantity of serum, is placed and viewed with an eye piece furnished with a micrometer, showing a number of square spaces. The corpuscles are counted in these spaces, and then, by a simple process of multiplication, the number in a cubic millimetre is ascertained. In the case of the blood exhibited by Dr. Lawson, this number exceeded 4,455,250.

Professor T. Rupert Jones gave a very interesting account of the recent researches, chiefly by himself and Mr. Kitchen Parker, in the structure and classification of foraminifera.

A MICROSCOPICAL examination of the root-fibres of pines damaged by Phylloxera leads M. Cornu to consider the injury due to mechanical causes, and not to any poisonous injection The introduction of the insect's sucker into the tissues causes their fading (not rotting), and the opposite cells swell. The affected cells have their longitudinal growth arrested, and from this arise tension and swelling, and a rapid exfoliation of the vertical layer required for the protection of the tissues.

## EMBRYOGENY OF THE FLEA.

IN the *Comptes Rendus* for November 15th is a paper by M. Balbiani on the Embryogeny of the Flea. He finds the egg of *P. felis* better adapted to researches than that of other species, such as *canis* and *irritans*. It is more transparent, and permits the various stages of development to be better observed. As the flea's egg has been described by former observers, and especially by Leuckart, M. Balbiani merely observes concerning its envelopes, that they consist in a chorion and vitelline membrane, both very thin, transparent and colorless. The chorion is homogeneous, without sculpture, or superficial reticulations. The rugose shell-like aspect its surface presents does not arise from this membrane, as Leuckart thought, but is caused by a coating the egg receives at the moment of its expulsion. The micropyle openings of the chorion are numerous, and are found at the anterior as well as at the posterior pole. In these two regions they are grouped in circular spaces, larger in the former, where the micropyle holes number forty-five to fifty, while in the latter there are only twenty-five to thirty. In the anterior group only has M. Balbiani seen spermatic filaments engaged. One or two days after laying, the formation of the embryon begins by a thickening of a portion of the blastoderm, in the form of a band, at first broad and diffuse, but which gradually concentres on the ventral line of the egg. The embryonary bandelet continues to grow at its posterior part, whence it makes a fold which penetrates the vitellus, and bends round to the dorsal, or opposite, side of the egg. This replicated, or caudal, extremity of the embryo thus has for its origin a veritable invagination of the blastoderm at the posterior pole, while, throughout the rest of its length, the embryo results from a local transformation of the blastodermic vesicle, and consequently remains external to the vitellus. This mode of formation of the embryo of the Pulicids presents a type intermediate between that of the Dipters, in which the whole embryo is exterior, and that of the Hemipters, in which it is chiefly, and sometimes entirely, formed at the expense of a portion of the blastoderm invaginated in the vitellus. After remarking that the egg of the flea is too small to make sections to exhibit the embryonic layers and the part they play in the process of development, M. Balbiani observes, there is no difficulty in following the development of the two membranes which have received the names of the amnios and serous envelope. With their formation, the first period of development terminates, and at this early stage of evolution, the organ of reproduction is already visible in the form of a small cluster of clear cells on the internal surface of the abdomen, immediately below the posterior margin of the vitellus. No envelope surrounds this mass of germinal cells, and the author formerly mentioned a similarly precocious appearance of reproductive elements in Aphidians and Lepidopters. The commencement of the second development period is marked by the appearance of the rudiments of cephalic appendages—antennæ and mouth-organs—which last, by progress of evolution, come to be organized as in maxillary or abrading insects (*broyeurs*). We know that the larva of the flea feeds on solid matters, while the perfect insect has a mouth adapted to suction. Another peculiarity is the appearance of the rudiments of thoracic members, though the larva is born in an apodal state. "This tendency to produce appendages like the legs of other insects, and which are destined to abort in the embryo itself, is a very interesting fact for the partisans of the doctrine of evolution, while it is inexplicable to those who believe in the invariability of species." Among the phenomena of the third and last evolution period, M. Balbiani mentions, the rupture of the serous or external envelope of the cephalic region of the embryo, its concentration on the dorsal surface as a crumpled mass, and, finally, its penetration in the vitelline sac, or mid intestine, by an opening in the back of the embryo. At the close of this period, a little horny plate is found, on the head of the larva, which enables it to split the membrane at the time of hatching. M. Künckel has described and figured this in *P. felis*, but M. Balbiani claims priority.

[Nature.]

## CHARLES BLACKER VIGNOLES, F.R.S.

THIS celebrated engineer died on the 17th of November, 1875, at Hythe, at the age of eighty-three years. Although he won his fame mainly as an engineer, yet his services to science were of considerable importance. Mr. Vignoles was descended from an ancient French family which had taken refuge in England after the repeal of the Edict of Nantes. His father, Captain Vignoles, was an officer in the 43d Regiment of the Line, and his mother was a daughter of Dr. Charles Hutton, the celebrated mathematician and professor at the Royal Military Academy, Woolwich. When young Vignoles was only twelve months old, his father lost his life at the storming of Pointe-à-Pierre, Guadaloupe, when Sir Charles Grey, the commander of the British forces, gave the former a commission in the army. Thus his career has been an unprecedentedly long one. His grandfather, Dr. Hutton, undertook his education, and the pupil certainly turned out a credit to his teacher. For a short time before the conclusion of the great war which ended in 1815, Vignoles served under the Duke of Wellington on the Continent, and after visiting America about 1822, he returned to England and threw himself enthusiastically into the engineering profession. The railway movement was just then gathering strength, and Vignoles was associated with some of the earliest efforts to establish lines in this country. After the Liverpool and Manchester Railway Bill was thrown out of Parliament in 1824, he was, in 1825, selected by Messrs. Rennie to take charge of the new surveys which the Liverpool Committee ordered. From this time forward Vignoles was ever in the van of the railway movement, and had the foresight to predict, amid some incredulity and ridicule, to what gigantic results it would lead. In 1826 he was employed by Messrs. Rennie to make surveys for a line from Nine Elms, Vauxhall, Dorking, and Shoreham, to Brighton; and in 1834 he escorted M. Thiers over the railways which had been built under his superintendence. The great French Minister's dictum was, "I do not think railways are suited for France." In England, in Ireland, on the Continent, and in America, Mr. Vignoles took a prominent part in the carrying out of great railway and other engineering works. Probably one of his greatest works was the magnificent suspension bridge over the Dnieper at Kieff, commenced in 1848 and finished in 1853, at a cost of 432,000*l*. A fine model of this is now in the Crystal Palace.

Mr. Vignoles became a member of the Institution of Civil Engineers in 1827, and was elected President in 1870, when he gave a very able address on the progress of engineering. In 1842 he gave a series of remarkable lectures as Professor of Civil Engineering at London University College. In 1855 he was elected a Fellow of the Royal Society; he was also a Fellow of the Royal Astronomical Society, and was for long a regular attendant at its meetings. The Eclipse party of 1860 was to a great extent indebted to him for all the local arrangements, and its success was mainly due to his exertions. He was also Honorary Treasurer of the Expedition of 1870, was on board the *Psyche* when she struck, and was afterwards indefatigable in aiding the necessary arrangements. In the early part of its career he took an active part in the meetings of the British Association, contributing several papers to the Mechanical Section.

As might be expected, Mr. Vignoles was a man of great energy and strong physical constitution. On the Thursday before his death he attended the annual inspection, in his capacity of Lieutenant-Colonel, of the Engineers and Railway Volunteer Staff Corps. On the Saturday following he was struck with paralysis, and remained unconscious till his death on the following Wednesday.

## IRON AND STEEL BY THE KNOWLES PROCESS.

IN a communication to *Iron* respecting the "Production of Steel from the Ore," Sir Francis Knowles says: "It occurs to me that your readers may wish to know in what manner I propose to practically effect the fusion of such steel in large quantities so as to evade the cost of melting once or oftener in pots. I shall suppose, for this purpose that we have obtained our metallic sponge from ore originally free from phosphorus, and calcined, if need be, to expel sulphur. The reduction to this state may be effected by charcoal, but I much prefer, when it can be had, reduction by a current of light or heavy carburetted hydrogen gas, as this reduction takes place at a much lower temperature and is very complete. (Properly managed, the gas given off in this reduction ought after passing through cold water to be pure carbonic oxide.) This sponge is then to be ground up with the proper flux, and compressed into small cakes. A basis of richly carburetted pure pig-iron infusion having been run out into the converter, the current of burning pyrogen gas, as described by me in former papers, is to be let on for a few minutes, after which the prepared ore is to be gradually added to the bath, the gas current being continued until the exact degree of cementation of the metal required in the aggregate is attained. The weight of sponge being known, and the degree of its carburation, if any, as well as that of the original metal bath, the proper proportions are easily attained. If the flux have been well adjusted, the cinder or scoria ought to be a perfect glass free from metallic oxide (save where manganesiferous materials are present), and suitable for glass-making. The heat evolved by the complete combustion of pyrogen is sufficient for the fusion of the prepared ore in a proper furnace without metal; but I hesitate to advise it, because, as it seems to me, it would render more difficult the due degree of cementation, and might corrode the lining of the furnace. In all cases the finery, furnace, or converter must be gradually heated up to the point at which the bath is to be run in, as sudden contractions by heat may injure the lining. The ores which I prefer are the best magnetic or spathose, well calcined, and the same may be generally said as to the metal of the bath; but a splendid basis may be obtained in metal produced from pure brown hæmatite, such as the ores of the Duc d'Arenberg, which are rich in oxide of manganese.

"In the above, I contemplate the production of a high-class workable steel, such, for example, as would require, in the old method of cementation, Russian or other charcoal bars at £20 a ton and upwards. If to this we add the cost of cementation and melting in pots, we get a pretty good margin for the above operations, raw materials included. This steel may be used also for casting articles in moulds, as proposed in my previous letter. Axes so made could be worn down to the 'eye' itself, to the joy of the backwoodsman."

## HOW LONG MAY THE EFFICACY OF VACCINATION BE RELIED ON?

THE above question is so often asked, and so variously answered, and often answered so little in accordance with the actual facts, that we are not much surprised at the growing distrust in the efficacy of vaccination as a safeguard against small-pox.

Jenner taught that protection by vaccination was life-long. It did not require the observations of half a century to disprove this statement of the great discoverer.

The question, "How long?" can not with certainty be answered. It is generally agreed by all observing members of the profession that protection by thorough vaccination is for a few years certainly reliable. It is highly probable that one person may be protected by vaccination for a longer time than another person of equally distinct cicatrix.

The range of susceptibility to any contagion is very wide in the human family. One individual will contract disease, while another equally exposed will escape with impunity. It is certainly safe to vaccinate indiscriminately every five years, or oftener if the disease prevail. At least make the effort. "Best safety lies in fear." But, since specific disease enters so largely into the catalogue of human ills, we unhesitatingly commend the employment of animal vaccine virus.

We have repeatedly vaccinated individuals well advanced in years, and obtained a typical vesicle, though numerous efforts had failed in the same person in years gone by, subsequent to vaccination in early life. The writer was vaccinated in his first decade, and well remembers some of the constitutional symptoms. A distinct cicatrix is still visible, and bears testimony to the completeness of the work. He also believes that that vaccination afforded immunity against small-pox for more than a third of a century. The following are his reasons for the hope within him:

During the late war, being on duty in the valley of the Mississippi, the writer was designated to muster for pay, and to sign the rolls for all the patients and attendants in and about the small-pox hospital, situated a few miles outside of Memphis. Military orders are peremptory, and this one was promptly complied with. On reporting at the hospital, he was forthwith conducted into every occupied apartment of the building, thus coming in contact with the disease in all its stages, except the stage of incubation, which is the very least dangerous, and perhaps never seen in a small-pox hospital, except in an attendant, as that stage is generally over before being sent to hospital.

The muster completed and the rolls signed, he returned to the Post Hospital, of which he had charge, and vaccinated himself and all unvaccinated attendants most thoroughly. Upon himself no symptoms of a vesicle appeared.

Within the next three months numerous cases of small-pox occurred in the fort, in the prison, and in the Post Hospital, bringing him daily in contact with its emanations, and yet he escaped the disease.

In 1872–73, at Parker's Landing, Pa., there occurred an epidemic of small-pox of very fatal type. Here, again, the writer came in contact with the disease in its worst form, ministering to the sufferers' wants night and day, and yet suffered no inconvenience in health from the contact.

After making a call on a case of small-pox, he would sponge off his clothing, hands, face and feet with gasoline. (Gasoline, by the way, turned out to be one of the very best antiseptics, and one which we freely used before knowing its full value.) Here, again, he vaccinated himself freely, but to no effect.

During the present winter the writer was detained at Cumberland City, Md., for a few hours. Here small-pox is epidemic with unusual fatality. The writer procured from the Pennsylvania Vaccine Agency a quill of animal virus, with which he again vaccinated himself, and at this writing there is a typical vesicle in full bloom on his arm. The constitutional symptoms are also well marked.—*A. D. Binkerd, M.D.*

## TREATMENT OF CEREBRAL RHEUMATISM BY CHLORAL.

M. BOUCHUT, in a memoir, says that cerebral rheumatism is only a form of meningitis. Examination of the membranes of the brain reveals a considerable venous stasis, with an opaline infiltration of the pia mater, caused by numerous leucocytes. The opththalmoscope discloses a serous infiltration of the papilla and of the retina adjoining, with dilatation of the retinal veins, which represent corresponding changes in the pia mater and in the brain. Rheumatism of the brain is ushered in by delirium more or less violent, terminating by coma or by asphyxia, sometimes very rapid, which may cause death in a few hours. In three cases of this kind, a cure was obtained by means of hydrate of chloral, given by the mouth, in doses of from forty-five grains to one and a half drachms, once or twice at short intervals, so as to obtain an immediate abatement of the agitation the patients presented.—*Med. and Sur. Jour.*

[Nature.]

## THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS.

(Continued from page 45.)

THE idea that the chain when thus put in motion will be disturbed by its centrifugal force from the shape it holds while at rest must point to one of two conclusions; either (1) the chain will tend to open out into a complete circle, or (2) it will, on the contrary, tend to stretch itself at its lower bend to a curvature of infinite sharpness.

But you observe that no tendency to either change of form appears. On the contrary, the chain, instead of taking spontaneously any new form in virtue of its centrifugal force, has plainly assumed a condition under which it is with difficulty disturbed, alike from its existing form, or from any other which I communicate to it by violently striking it. Such blows locally indent it almost as they would bend a bar of lead.

In spite, however, of this quasi-rigidity which its velocity has imparted to it, it does, if left to itself, slowly assume, as you perceive, a curious little contortion, both as it approaches and as it recedes from the lower bend of the catenary; and it is both interesting and instructive to trace the cause of the deformation.

I have already explained that the speed of the chain subjects it throughout to longitudinal tension. Speaking quantitatively, the tension is equal to the weight of a length of the chain twice the height due to the velocity. This is $\frac{v^2}{g}$, and thus, as the speed is 40 feet per second, $\frac{1600}{32}$=50 feet, or with this chain about 14 lbs.

Now in travelling through the lower bend of the catenary, the chain passes from being nearly straight, to being sharply curved and immediately straightened again, and this change of form involves a continued pivoting of link within link, the friction being called into action by the tension which presses the surfaces together. Each link thus in succession resists this pivoting with a definite force, and the resistance, in effect, converts what appears to be a perfectly flexible combination into one possessing a tangible degree of stiffness, and the oblique attitude assumed by the chain as it approaches the bend, and the slight back turn which it assumes as it emerges from the bend, are alike consequences of this factitious stiffness.

For in virtue of gravity, the running chain, like the chain at rest, tends always to maintain the original catenary; and in virtue of its speed of rotation, it seeks to maintain (not preferentially the catenary, but) whatever form it for the moment possesses. Hence its departure from the true catenary was, as you saw, gradual. But when the figure of equilibrium is once attained, the persistency of form imparted by velocity serves to maintain this figure as indifferently as any other. Hence the figure is that in which equilibrium subsists between the force of gravity seeking to restore the catenary, and the factitious stiffness resisting the necessity of bending and unbending.

The slowness with which the form is assumed, and its steady persistency when once assumed, alike bear witness to the truth of the proposition which it is the object of the experiment to verify.

The stream of fluid in the tortuous flexible pipe would behave in a strictly analogous manner.

### II.

IT might at first sight appear that I have now the materials for the proof of my chief proposition, the assertion of the unresisted progress of a submerged body; for such a body might be assumed to be surrounded by a system of imaginary pipes, as shown in Fig. 8; and each of these pipes being

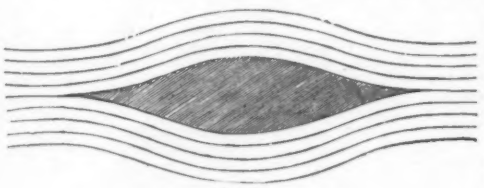


FIG. 8.

in equilibrium endways, that is to say, the flow of fluid through it not tending in the aggregate to move it endways, neither, it might be said, would the flow of fluid tend to move the submerged body endways. But this reasoning would not be sound. The pipes we have hitherto been considering have been of uniform sectional area throughout their length, an assumption which has been necessary to the treatment pursued, as the velocity has in each case been assumed to be uniform throughout the pipe. The section of the pipe may have been square, circular, trapezoidal, or any other form; but the area of the section has been assumed to be the same throughout the length of the pipe.

But pipes of uniform sectional area do not truly represent the flow of a fluid past a submerged body. I shall presently ask you to consider the fluid as flowing past the body through a system of imaginary pipes; but to render the assumption admissible, the sides of the imaginary pipes must not be so placed as to interfere with the established course of the fluid, whatever that may be; in other words, if, for the sake of illustrating the behavior of the fluid, we assume that it is divided into streams or filaments flowing through imaginary pipes, we must accept such a form for those imaginary pipes that their sides exactly follow the paths of the adjacent particles of fluid.

Now such a rule may, and probably will, require the imaginary pipes to be of varying sectional area throughout their length. Therefore, before we can apply the analogy of the flow of fluid through pipes to the flow of a fluid past a submerged body, it is necessary to consider the behavior of fluid in pipes of varying sectional area.

It is, I think, a very common but erroneous impression, that a fluid in a pipe exercises, in the case of its meeting a contraction (see Fig. 9), an excess of pressure against the entire converging surface which it meets, and that, conversely, as it enters an enlargement (see Fig. 10), a relief of pressure

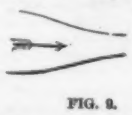


FIG. 9.

FIG. 10.

is experienced by the entire diverging surface of the pipe. Further, it is commonly assumed that, when passing through a contraction (see Fig. 11), there is in the narrow neck an excess of pressure due to the squeezing together of the fluid at that point.

These impressions are in no respect correct; the pressure at the smallest part of the pipe is, in fact, less than that at any other point, and *vice versa*.

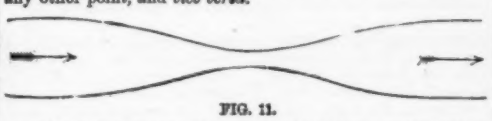


FIG. 11.

If a fluid be flowing along a pipe which has a contraction in it (see Fig. 12), the forward velocity of the fluid at B must be greater than that at A, in the proportion in which the sectional area of the pipe at B is less than that at A; and therefore while passing from A to B the forward velocity of the fluid is being increased. This increase of velocity implies the existence of a force acting in the direction of the motion; that is to say, each particle which is receiving an increase of forward velocity must have a greater fluid pressure behind it than in front of it; for no other condition will cause that increase of forward velocity. Hence a particle of fluid, at each

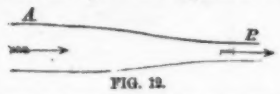



FIG. 12.

stage of its progress along the tapering contraction, is passing from a region of higher pressure to a region of lower pressure, so that there must be a greater pressure in the larger part of the pipe than in the smaller, and a diminution of pressure at each point corresponding with the diminution of sectional area; and this difference of pressure must be such as to supply the force necessary to establish the additional forward velocity required at each point of the passage of the fluid through the contraction. Consequently, differences of pressure at different points in the pipe depend simply upon the velocities at those points, or, in other words, on the relative sectional areas of the pipe at those points.*

It is simple to apply the same line of reasoning to the converse case of an enlargement. Here the velocity of the particles is being reduced through precisely the same series of changes, but in an opposite order. The fluid in the larger part of the pipe moves more slowly than that in the smaller, so that, as it advances into the enlargement, its forward velocity is being checked; and this check implies the existence of a force acting in a direction opposite to the motion of the fluid, and each particle being thus retarded must therefore have a greater fluid pressure in front of it than behind it; thus a particle of fluid at each stage of its progress along a tapering enlargement of a pipe is passing from a region of lower pressure to a region of higher pressure. As is well known, the force required to produce a given change of velocity is the same, whether the change be an increase or a decrease. Hence, in the case of an enlargement of a pipe, as in the case of a contraction, the changes of velocity can be satisfied only

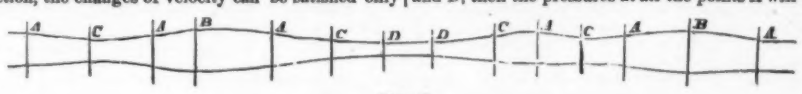



FIG. 18.

by changes of pressure, and the law for such change of pressure will be the same, *mutatis mutandis*.

In a pipe in which there is a contraction and a subsequent enlargement to the same diameter as before (see Fig. 11), since the differences of pressure at different points depend on the differences of sectional area at those points, by a law which is exactly the same in an enlarging as in a contracting pipe, any points which have the same sectional area will have the same pressures, the pressures at the larger areas being larger, and those at the smaller areas smaller.

Precisely the same result will follow in the case of an enlargement followed by a contraction (see Fig 13).†

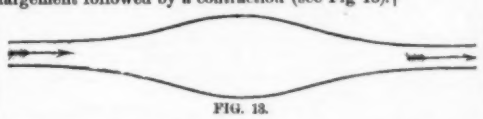


FIG. 13.

This proposition can be illustrated by experiments performed with water.

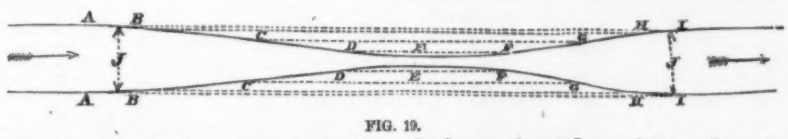



FIG. 19.

Figs. 14, 15 show certain pipes, the one a contraction followed by an enlargement, and the other an enlargement followed by a contraction. At certain points in each pipe, vertical gauge-glasses are connected, the water-levels in which severally indicate the pressures in the pipe at the points of attachment.

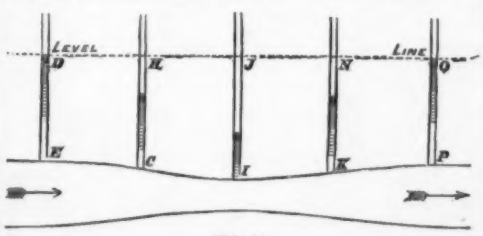



FIG. 14.

In Fig. 14 the sectional areas at P and E are equal to one another. Those at C and K are likewise equal to one another, but are smaller than those at P and E. The area at I is the smallest of all. Now, if the water were a perfect fluid, the pressures P Q and E D would be equal, and would be greater than C H and K N. C H and K N would also be equal to one another, and would be themselves greater than I J.

The results shown in Fig. 15 are similar in kind, equal pressures corresponding to equal sectional areas.

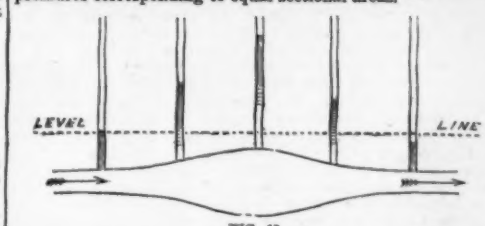



FIG. 15.

As water is not a perfect fluid, some of the pressure at each successive point is lost in friction, and this growing defect in pressure is indicated in the successive gauge-glasses in the manner shown in Figs. 16, 17.

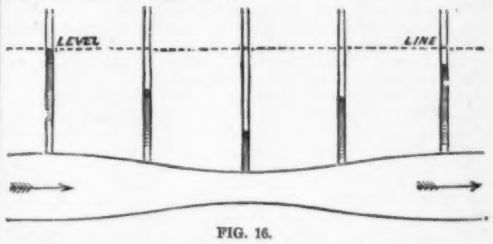



FIG. 16.

As the pressure of the perfect fluid in the pipe at any point depends upon the sectional area at that point, it follows that the amounts of the pressures are independent of the distance,

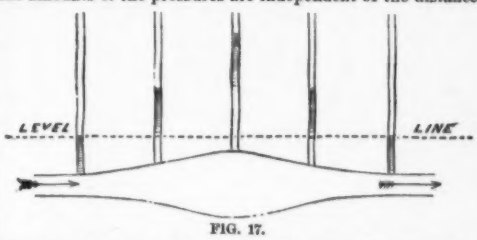



FIG. 17.

as measured along the pipe, in which the area of the pipe alters; so that if in the pipe shown in Fig. 18 the areas at all the points marked A are equal, if also the areas at all the points marked B are equal, and so also with those at C and D, then the pressures at all the points A will be the same, the pressures at all the points B will be the same, and so with those at C and D.

Since, then, the pressure at each point depends on the sectional area at the point and on that only, it is easy to see that the variations in pressure due to the flow are not such as can cause any total endways force on the pipe, provided its sectional area at each end is the same.

Take the pipe shown in Fig. 19. The conical portion of pipe A B presents the same area of surface effective for endways pressure as does the conical portion H I, only in opposite directions. They are both subject to the same pressure, being that appropriate to their effective mean diameter J. Consequently the endways pressures on these portions are equal and opposite and neutralize one another. Precisely in the same way it may be seen that the endways pressures on B C, C D, D E, exactly counteract those on G H, F G, E F; and in precisely the same way it may be shown that in any combination whatever of enlargements and contractions, provided the sectional area and direction of the pipe at the two ends are the same, the total endways effect impressed on the pipe by the fluid flowing through it must be *nil*.

In the experiment I am about to show you, the several propositions which I have been elucidating will be seen to be verified step by step, if due allowance be made for the effect of friction.

(To be continued.)

* See Supplementary Note B.

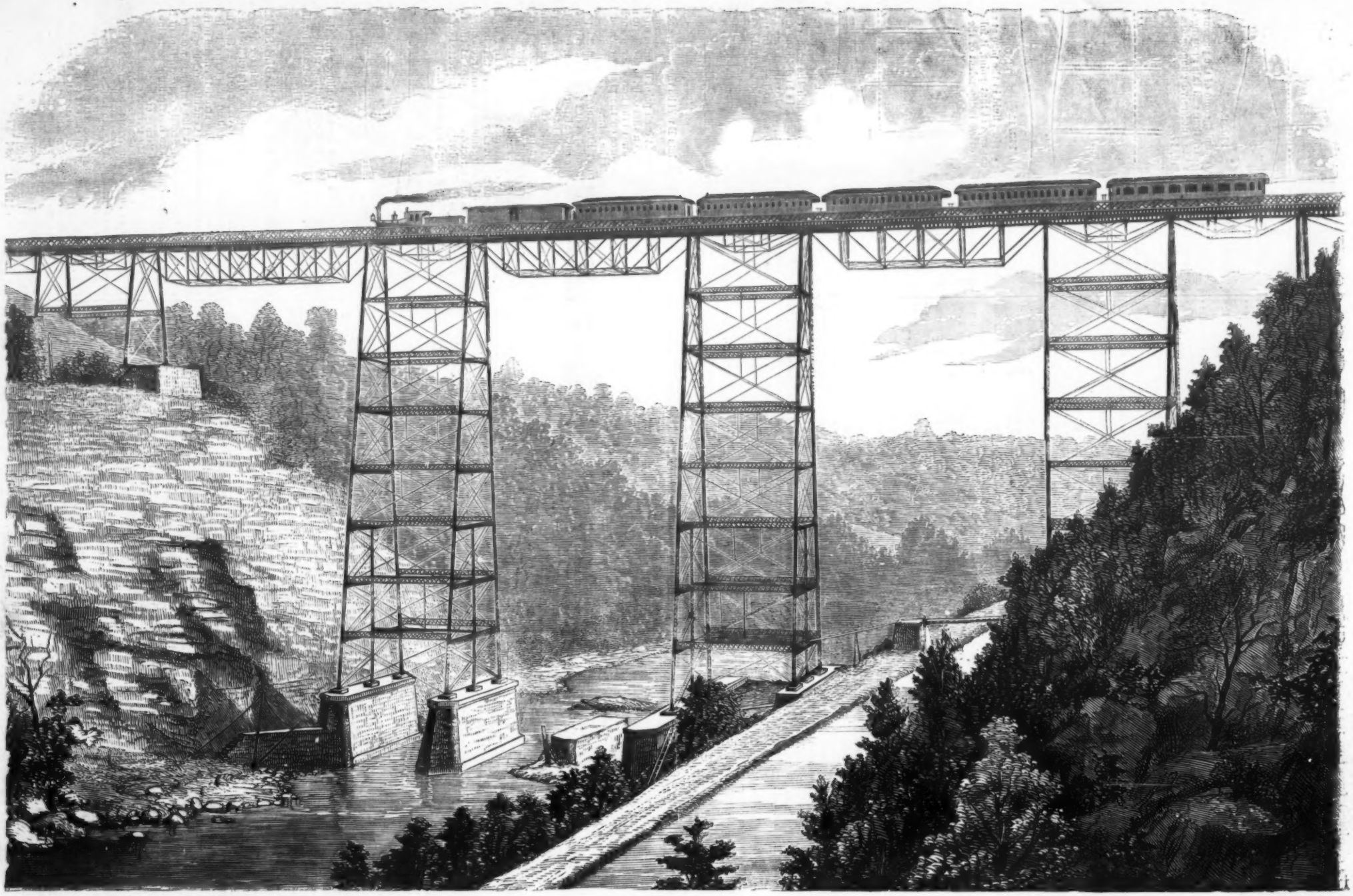
† In a perfect fluid, we may say in a sense, the *vis viva* of each particle remains constant. If the particle is stationary, the *vis viva* is entirely represented by the pressure; if it be under no pressure, the *vis viva* is entirely represented by the velocity; if it be moving at some intermediate velocity, the *vis viva* is partly represented by the pressure and partly by the velocity.

## TO THE MEMORY OF A REMARKABLE SCIENTIST.

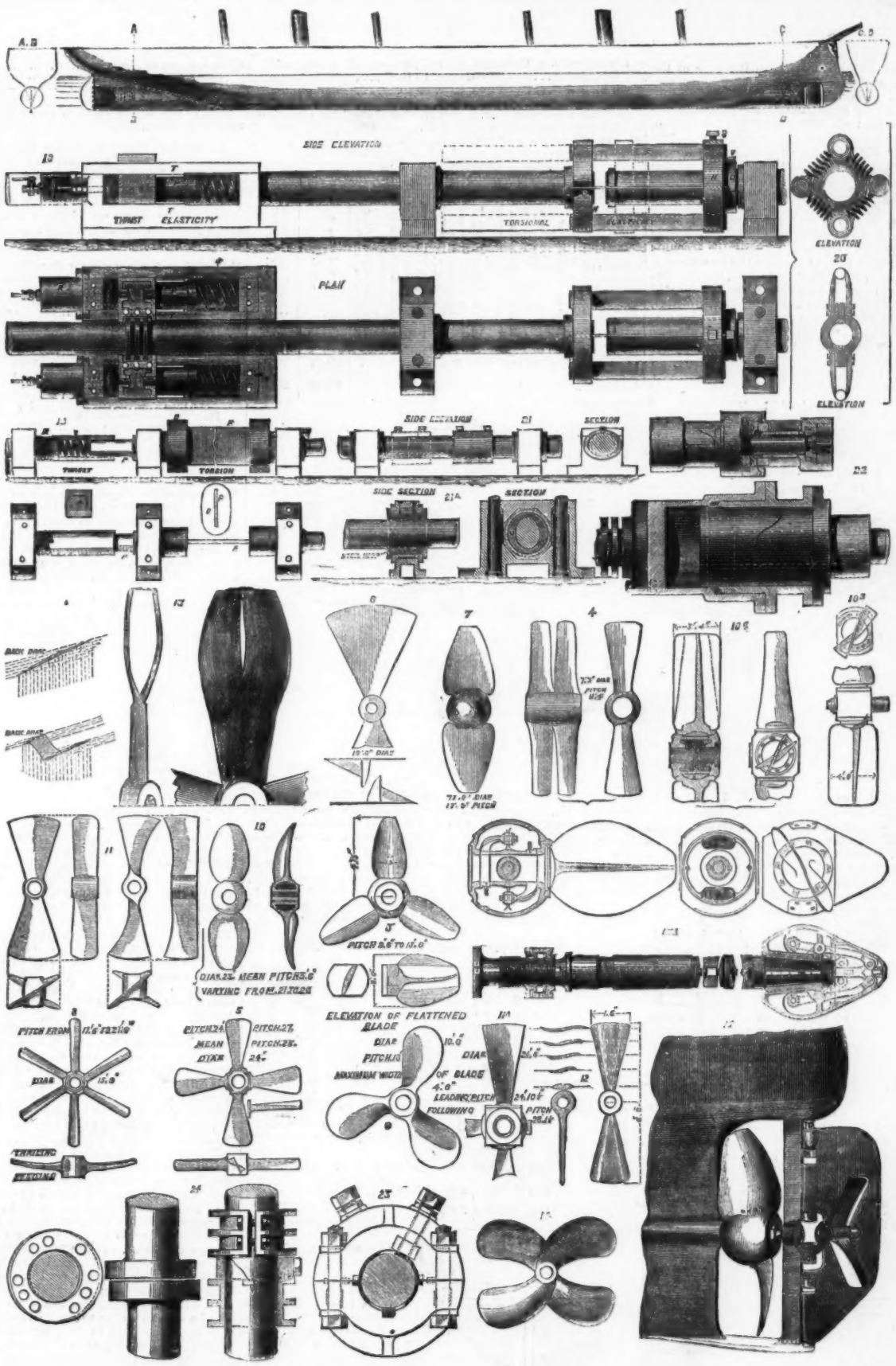
THERE has just been placed in Westminster Abbey a marble scroll bearing an appropriate inscription to the memory of Jeremiah Horrocks. The movement for such a memorial was commenced some time ago, and is referred to in *Nature*, vol. x. p. 190, and xi. p. 31. The scroll is affixed to the pedestal of the monument of John Conduitt, nephew of Sir Isaac Newton, which is situated at the extreme west end of the north side of the nave, and exactly opposite that of Newton, at the extreme east end. The inscription is as follows:

In Memory of
JEREMIAH HORROCKS,
Curate of Hoole, in Lancashire,
Who died on the 3d of January, 1641, in or near his 22d year;
Having in so short a life
Detected the long inequality in the mean motion of Jupiter and Saturn;
Discovered the orbit of the Moon to be an ellipse;
Determined the motion of the lunar apse;
Suggested the physical cause of its revolution;
And predicted from his own observations the Transit of Venus,
Which was seen by himself and his friend William Crabtree
On Sunday the 24th of November (O.S.) 1639:
This Tablet, facing the Monument of Newton,
Was raised after the lapse of more than two centuries, December 9, 1874.

The friends of Horrocks are indebted for the inscription to the joint labor of the Dean of Westminster and Prof. H. J. S. Smith. It is a simple act of justice to state that the idea of this tablet was suggested by two ladies, Mrs. Orme and Mrs. Patmore, and that upon the latter has fallen the burden and heat of the day so far as the correspondence with subscribers is concerned.—*Nature*.



THE PORTAGE VIADUCT.—NEW-YORK AND ERIE RAILWAY.—DESIGNED BY GEORGE S. MORISON, C.E.—(*See page* 55.)




# SCREW-PROPELLERS, THEIR SHAFTS AND FITTINGS.

[The Engineer.]

## SCREW-PROPELLERS, THEIR SHAFTS AND FITTINGS.

By HAMILTON W. PENDRED.

THE grand aim of all inventors who have dealt with the screw has been, of course, to increase its efficiency; it would be quite beside the purport of this paper to refer in detail to what has been done years ago in this matter; the author, it will be remembered, is dealing with recent practice, and with it only. The labors of recent inventors have been devoted to reducing vibration, and obtaining a greater thrust per indicated horse-power than is available with the common screw; they may not themselves realize this truth, but the fact remains that the screw which gives the greatest thrust for the least expenditure of power is—other things being equal—the best. No one has addressed himself within the last few years with more success, perhaps, to increasing the efficiency of the screw than Mr. Robert Griffiths. His attention was first directed to the screw-propeller on witnessing some experiments made by Captain Ericsson on the Regent's Canal about thirty-five years ago, and he began his own experiments about ten years later. His first idea was to find out what portion of the screw's disc was most effective—in other words, the relation of the outside of the disc to the inner portion. He decided to fill up the central portion with a sphere, anticipating a certain calculable loss, but instead of loss he had a slight gain in speed. Working this out experimentally, he found the best size of sphere to be between a quarter and one third the diameter of the screw. Experimenting then on the shape of the blades, he found that the width of the blades just over the sphere should be equal to one third the diameter of the screw, and at the points one ninth thereof, with a movable-bladed screw he found that when the pitch was set to equal 1¼ diameters, the water had no tendency either to increase or diminish the pitch, but that when set coarser the water tended to increase that coarseness, and when set finer the water tended to increase that fineness. The author would draw attention to this as a point in the science of the screw-propeller worthy of notice. A screw-propeller occupies an intermediate position between a disc and a paddle-wheel; if the pitch of a screw were reduced to the minimum, then it would be merely a disc; if, on the other hand, it had a maximum pitch, so to speak, it would become a paddle-wheel, and would tend to turn the ship round and round on her centre, because of the difference of density of water above and below the centre of the shaft. It seems then to the author that any screw acts to some extent as a paddle-wheel, and must tend to give a ship what sailors call a port or starboard helm, and that a fine pitch must be the best, while if area be wanting, it is better to get it by multiplying the number of the blades rather than by adding to their length.

Mr. Griffiths has latterly advanced certain views respecting the mode of fitting screw-propellers. He advocates, first, the inclosing of the screw within a tube-like case or shield, to which the water coming to the screw can only obtain access from below; the diagram No. 1 shows the arrangement. The author will not enlarge on the scheme; it is one which has provoked much controversy. Mr. Griffiths claims, as regards the inclosure of the screw, that the water is more equally fed to the screw, more closely confined to it, and is led from it in such a direction as is best calculated to economize the engine power and give the best working results. He also claims that the inclosing of the screw protects it from fouling and from danger of fracture. Mr. Griffiths likewise advocates the duplication of screws, not on the ordinary twin principle, but in the manner shown in diagram No. 2, one screw being placed in the head and another at the stern of the vessel.

In a paper which Mr. Griffiths read before the Institution of Naval Architects, he stated that his attention was first drawn to the necessity of having bow and stern screws, from the danger attending the use of the long steamers now employed, that danger being increased by making the safety of the ship dependent on a single set of machinery, an arrangement also that increases the difficulty of constructing machinery, owing to the immense castings and forgings necessary

to develop the great engine-power demanded to secure high speed. The opponents of the shield-tube aver that while the screw has less chance of becoming fouled, should it become fouled it would be infinitely more difficult to clear than an uncovered screw. As regards the use of the tunnel as a water-feeder to the screw, Mr. Griffiths cites the case of the Dwarf, which, with a speed at first of about 9 knots, was subsequently reduced to about 3½ by planking up the after-run of the vessel; this result he attributes solely to the circumstance that the alteration of lines obstructed the flow of water to the screw.

In a second paper, Mr. Griffiths stated that, in the course of experiments with a model, he found that when he divided the power and applied one half to the stern and another to the bow screw, each screw being inclosed within a tunnel, the speed of the model was increased nearly as the square root of the power, but when the power was doubled alone on the bow or stern screw, then the increase of speed was only as the cube root of the power. The way Mr. Griffiths accounts for this is that a better water supply reaches the screw.

Having said so much of a particular and important innovation in existing practice in screw propulsion, the author will now proceed to say a little about the nature of that practice, as carried out by the best firms in the present day. The diagrams illustrate a somewhat singular diversity of practice amongst engineers, the various screws varying greatly from each other, both in the shape and proportion of their blades and the number of blades forming each.

Diagram No. 3 illustrates a three-bladed screw, fitted to H.M.S. Lapwing by Messrs. Rennie. The diameter of this

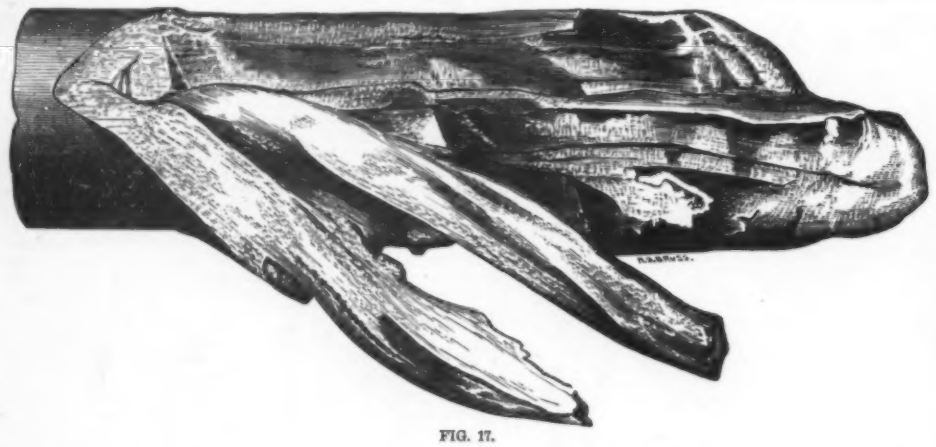


FIG. 17.

screw is 8 ft. 6 in., the pitch varying from 9 ft. 6 in. to 13 ft. 6 in. This screw is a fair example of a Griffiths three-bladed propeller, and was designed to comply with those conditions discovered by Mr. Griffiths as regulating the most efficient action of his propeller. It has a boss, which tapers outwards, and the blades are slightly curved forward, the pitch of the screw is uniform. The nominal horse-power of the Lapwing's engines was 80, the indicated power 502, or 6.25 times the nominal; the diameter of the propeller was 3½ times that of the boss.

Diagram No. 4 illustrates a double two-bladed Mangin screw, fitted to H.M.S. Bullfinch. It is 7 ft. 3 in. in diameter, pitch uniform; nominal horse-power of engines, 80; indicated horse-power, 458·5; or about 5¾ the nominal. This form of screw is frequently made with a varying pitch, and is also made as shown in diagram No. 5, which is a more modern form than that of the screw of the Bullfinch. In February, 1868, H.M.S. Blanche was officially tried, being fitted with a Mangin screw; diameter, 14 ft. 7 in.; pitch of the leading portion of the blade, 15 ft. 7 in., and of the trailing portion 17 ft.; the mean length of blade on keel line being 12 ft. The speed of the ship was 13·631 knots an hour, the screw making 88½ revolutions with full boiler power; half boiler power gave 11.78 knots. The official report stated that the use of full power created a heavy thumping action upon the ship's stern, the same action being very marked during comparative trials with the Shannon about ten years ago.

Diagram No. 6 illustrates a common two-bladed screw by Messrs. James Watt & Co., 16 ft. in diameter and 20 ft. pitch; length of blade on keel line, 3 ft. 4 in.; indicated horse-power of engines, 458. A propeller of this kind, provided with lifting gear, was fitted to H.M. troop-ship Simoom.

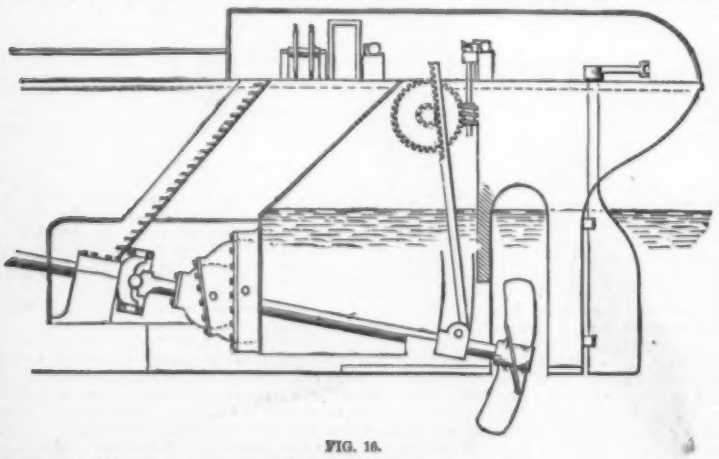


FIG. 16.

Diagram No. 7 illustrates a two-bladed Griffiths propeller fitted to H.M.S. Collingwood by Messrs. Rennie. The author is not in possession of any particulars of its performance.

Diagram No. 8 represents a six-bladed screw having a diameter of 15 ft. 9 in., and a pitch varying from 17 ft. 6 in. to 21 ft. 6 in., fitted to the Egyptian Government steamer Charkieh, and the theory of its action was, that by sub-dividing the surface of the blades into many parts, a greater uniformity of action results; but comparative experiments with this and a three-bladed screw demonstrates that little advantage rested with either. The first-named screw was used from Malta to Alexandria; the latter screw was used from Venice to Alexandria, and the hourly consumption of coal was 34 cwt. 0 qr. 9 lb.; mean speed, 10·69 knots.

Trials of the Charkieh with a six-bladed propeller and a three-bladed propeller:

| Kind of Screw. | Consumption of coal per hour. | Mean speed. |
|---|---|---|
| 6-bladed .... | 33 cwt. 3 qr. 15 lb. .... | 10.65 knots. |
| 3-bladed .... | 34 cwt 0 qr. 9 lb. .... | 10.69 knots. |

The six-bladed propeller, however, caused the least vibration.

The following table shows the comparative particulars of this vessel with a six-bladed propeller and those of the steamship Ruahine:

*Charkieh and Ruahine.*

| Name of ship. | Displacement in tons. | Area of midship section in square feet. | Indicated horse-power. | I.H.P. / Area of midship section. | Displacement in. / I.H.P. | Speed in knots per hour. | Area of mid-section in square feet. / Total area of propelling surface in square feet. | Speed 3 × mid section / I.H.P. | Speed 3×3 √ displacement / I.H.P. |
|---|---|---|---|---|---|---|---|---|---|
| Charkieh... | 2200 | 463 | 1475 | 3.192 | 1.491 | 11.4 | 8.105 | 439.30 | 169.19 |
| Ruahine.... | 1850 | 494 | 1540 | 3.622 | 1.2 | 13 | 10.408 | 604.88 | 215.4 |

Diagram 10 illustrates the propeller of the latter vessel. Diagram No. 9 represents the two-bladed Griffiths screw fitted by Messrs. Maudslay to H.M.S. Lord Warden and Lord Clyde, which are sister ships. The diameter of the screws is 23 ft.; mean pitch, 23 ft. 6 in., varying from 21 ft. to 26 ft.; the indicated horse-power of the engines is 6705; number of screw revolutions, 63.3; speed of ship, 13.49; displacement, 9000 tons.

The following table shows the relative performances of H.M.S.'s Minotaur, Agincourt, and Bellerophon.

*Minotaur, Agincourt, and Bellerophon.*

| Name of ship. | Displacement in tons. | Area of mid-section in square feet. | Indicated horse-power. | I.H.P. / Area of mid-section in square feet. | Displacement in tons. / I.H.P. | Speed in knots per hour. | Area of mid-section in square feet. / Total area of propelling surface in square feet. | Speed ³ × mid-section. / I.H.P. | Speed ³×3 √ displacement ×³ / I.H.P. |
|---|---|---|---|---|---|---|---|---|---|
| H.M.S. | | | | | | | | | |
| Minotaur..... | 10675 | 1322 | 6193 | 4.684 | 1.629 | 14.16 | 9.713 | 606.71 | 216.616 |
| Agincourt.... | 9000 | 1187 | 6867 | 5.785 | 1.310 | 15.43 | 8.600 | 635.36 | 251.942 |
| Bellerophon.. | 7309 | 1207 | 6199 | 5.135 | 1.181 | 14.03 | — | 540.37 | 169.229 |

The next propeller to which the author would direct attention is the Lowe-Vansittart, and Table No. 7 shows the performance of this screw as contrasted with the Griffiths, fitted to the same vessel, the Scandinavian, while Table No. 8 shows the results attained with H.M.S. Druid. With the former vessel it was found that the speed attained while using the Griffith four-bladed screw, diagram No. 10A, was 11¾ knots, while with the Vansittart screw, diagram No. 10B, the speed was 12 knots, the indicated horse-power being equal in both cases. Each screw had four blades and was 25 ft. pitch.

VANSITTART TABLE.

*SS. Scandinavian, Liverpool to Montreal and back.—Registered tonnage, 1811.*

| | | |
|---|---|---|
| Nominal H. P. | 400 | 400 |
| Indicated ditto, average | 1800 | 1800 |
| Number of revolutions | 54 | 47¼ |
| Steam pressure | 30 lb. | 30 lb. |
| Average speed, knots | 11¾ | 12 |
| Displacement | 5375 tons | 5375 tons |
| Diameter of propeller | 18 ft. | 18 ft. |
| Pitch of ditto | 25 ft. | 25 ft. |
| Description of ditto | Griffiths | Lowe-Vansittart |
| Number of blades, steel | 4 | 4 |

*H. M. S. Druid, 350 H.P.*

| | | |
|---|---|---|
| Immersed mid-section, in square feet | 413·3 | 413·3 |
| Revolutions per minute, mean | 96·8 | 95·03 |
| Indicated H.P. | 2373·74 | 2271·71 |
| Speed of ship, knots | 12·986 | 13·064 |
| Speed 3 × mid-section, I.-H.P. | 381·3 | 402·0 |
| Description of propeller | Griffiths | Lowe-Vansit. |
| Slip per cent. | 10·37 | 8·01 |
| Number of blades | 2 | 2, gunmetal Henrietta Vansittart. |

Place of trial, Maplin Sands, on measured mile, by order of the Admiralty, December, 1869.

A trial was made in Stokes Bay with H. M.'s gunboat Fancy, to test the Vansittart and the common screw, and it was observed that there was an almost total absence of vibration when the former was used. The reversing of the propeller backed the boat in a perfectly straight line. The common screw is shown at diagram No. 11, and the Vansittart screw is shown on diagram No. 12, while table No. 9 gives particulars of both.

*Trial of H. M. S. Fancy with the Lowe-Vansittart propeller, made on the 24th June, 1868, against the common screw manufactured by Messrs. Penn.*

| Description of propeller | Common screw in gun-metal | Lowe-Vansittart in iron |
|---|---|---|
| Where tried | Portsmouth | |
| Draught of water forward | 6 ft. 8 in. | |
| " " aft | 7 ft. 1 in. | |
| Area of mid-section, immersed | 134 square feet. | |
| Steam pressure in boilers | 40 lb. | |
| Mean pressure in cylinders | 35·39 | 37·69 |
| Mean revolutions per minute | 180·19 | 153·3 |
| Indicated horse-power | 194 | 176 |
| Speed on measured mile, mean of 6 runs | 7·9 | 7·9 |
| Duty performed, or speed 3 × mid-section, I.-H.P | 374·5 | 377·8 |
| Diameter of propeller | 6 ft. | 6 ft. |
| Pitch of ditto | 6 ft. | 7 ft. 1 in. |
| Remarks as to vibration | Considerable | Very slight. |

Diagram 13 illustrates a propeller designed by Captain Rothwell, of the Cunard steamship Parthia. His object was to reduce the vacuum or back drag, and to give greater strength and efficiency to the blades without adding to the weight. To attain this end, the propeller was arranged as shown, a small blade being placed partly behind the larger one, and set a little coarser, both blades being set so that the leading edge of the rear blade and the rear edge of the large or leading blade are parallel with the line of shaft, both blades being curved, the large one convexed aft, the small one convexed forwards, both peripheries being connected. This form of blade can not be broken, it is claimed, by a sea striking it. The rear blade receives a clean thread of water and throws it off with the same velocity as the leading blade, thus destroying the back drag or vacuum of the large blade and reducing it to what would be found behind the small or rear blade. Also partially preventing the water from fouling or honeycombing the foreside of the blade; as the bladelet could be made to bolt on to the large blade, thus saving a new propeller, as some ships wear a propeller very quickly from that cause. Captain Rothwell says: "I have great faith in it reducing the vibration, on account of its peculiar construction, rotating in a volume of irregular density, this being the chief cause of vibration in ships propelled by the screw; a ship plunging into a heavy sea, as her stem falls the descending blade has an immense resistance opposed to it, while the opposite or ascending blade had its burden greatly lightened, causing the pressure of propulsion to be so unequal that if there is the least chance of looseness in the stern gland, or the shafting or bearing blocks not very firm, the result is great vibration, independent of what may be caused by the engine racing when the screw rises out of the water. In respect of the action of the propeller on the helm, with a right-handed screw, steaming full speed, most ships carry a little starboard helm. If one of such ships were to have her engines suddenly stopped and reversed full speed astern, the helm being placed amidships, then her stern will incline to starboard. I have always noticed that ships with a long fore-gripe turn very badly either way, and when moving either ahead or astern."

The next propeller for notice is that of Dr. Collis Browne, shown in diagram No. 14. It appears to be a right and left-handed screw, but it is not so, as the four blades really represent the action of but two, as it will be seen that one of either pair of blades is one portion of the same spiral as that of its companion. The performances of this propeller on board the Galatea, Trinity-house launch, were such that the same work was done by it by 60 lb. of coal per hour as was done by a Griffiths screw with a consumption of 80 lb. per hour.

Diagram No. 15 shows an arrangement for employing a supplemental screw to assist in steering a ship. Three mitre wheels transmit the motion of the main shaft to the supplemental screw mounted within the rudder. From the mode of arrangement it will be seen that the rudder has perfectly independent action, while at the same time the action of its contained screw is to force aside the ship's stern either to port or starboard. It is the invention of Mons. Victor Lutschaunig, Professor of Naval Architecture to the Imperial Academy at Trieste. He read a short paper on the subject before the Institution of Naval Architects in March of last year. In it he stated that the idea of swivelling the propeller of a ship in order to make it serve also as a means of steering, dates back to the year 1832, but that the practical difficulties of working the scheme with large ships were such as rendered that idea utterly impracticable. He therefore devised his scheme by which the main propeller is left to fulfil its legitimate functions, another independent screw being added for steering purposes. He further stated that his scheme was applicable to balanced rudders, but that they would no longer be requisite where his plan was adopted with his supplemental screw, it being preferable to balanced rudders; that critics of his system have suggested universal joints instead of toothed gear, but that his reply has been to them, first, that as it is expedient that the supplemental screw should revolve in a direction opposite to that of the main screw, toothed gear becomes a necessity; and, secondly, that by the use of a universal joint the rudder could not be unshipped. The advantages claimed are great increase of steering power; the possibility of turning the vessel from her position of rest, with the first revolutions of the engines; from the use of two screws revolving in opposite directions, the evil of a ship moving with a port or starboard helm is obviated; and that the rudder can be unshipped or shipped while the vessel is afloat.

The author now invites the attention of members to diagram No. 15A, which illustrates one of the most recent arrangements for feathering the blades of a screw. It is the invention of Mr. R. R. Bevis, of Messrs. Laird Bros., Birkenhead. The leading feature in the contrivance is that a portion of the shaft is hollow, and within is a rod riveted in the screw-boss with cranks upon the blade-shanks, and united at the other with a screw-collar on the shaft, and by this arrangement Mr. Bevis is enabled to feather the screw from the engine-room—a matter of advantage in war-ships, by placing all below the water-line. The thing has been successfully

tried in Mr. Brassey's yacht, the Kathleen, and after twelve months' service was found in good order.

Turning now from the forms and performances of screws in actual practice, the author invites the attention of the members of the Society to a different and more theoretical or experimental branch of screw-propeller action, and he gives the following abstract of certain experiments instituted by Professor Osborne Reynolds, to investigate the causes of the phenomena of racing observable with the screw when at work. In a paper read by Professor Reynolds on this topic before the Institution of Naval Architects, in April, 1873, he remarks that the tendency which the screws of steamships have under some circumstances to lose their hold of the water, appears to have its causes enveloped in mystery, for although the circumstances under which this racing occurs are such as appear, *prima facie*, to afford an explanation of it as being due, for instance, to the pitching of the vessel, exposing the screw at certain intervals, yet a closer examination indicates that something more than this is requisite, the mere casual stripping of the screw being, in his opinion, not sufficient to account for the screw losing its hold of the water; citing, as a proof of this, the tendency that a screw displays to race in the smoothest water, if working against a great resistance, as when towing another vessel, or even when starting its own. He states that his attention was attracted to this subject by the connection between the breakage or disturbance of the water-surface, and the consequent admission of the air to the blades. He remarked that the screw never raced without getting air, and the admission of air was always followed by racing. With the view of satisfying himself on this subject, he tried numerous experiments, one of which was made with a model fitted first with a screw of a small diameter, and which had about 1 inch of water covering, and the other was with a larger one that had but ½ inch of covering. When the boat was held still, the small screw did not race, whereas the large one did. In the opinion of the author, the tendency evinced by the thinly-covered screw to race is due, not alone to the suction of the air, but also to the fact that any screw will race if it has not sufficient water to react upon, and as the resistance of the water must depend upon its solidity, so to speak, it follows that when a screw is near the surface of the water the column acting against the thrust of the screw becomes broken, and the screw, losing resistance, races.

In the end of March, 1874, Professor Reynolds read a paper before the Institute of Naval Architects on the effects of immersion on screw-propellers, and he commented upon the results of two series of experiments—see Table No. 10—made by him with a model screw, 2 inches in diameter, and caused to rotate by a spring.

*Professor Reynolds' First Series of Experiments where same strength of spring was used.*

| Number of Experiment. | Depth of Immersion. | Time taken to Run Down. | Remarks. |
|---|---|---|---|
| | | Seconds. | |
| 1 | 1 | 19 | Did not race. |
| 2 | 2 | 19 | " |
| 3 | 3 | 20 | " |
| 4 | 2 | 20 | " |
| 5 | 1 | 20 | " |
| 6 | 5/8 | 20 | " |
| 7 | 1/2 | 20 | Raced a little at starting. |
| 8 | 3/8 | 12 | Raced. |
| 9 | 1/4 | 12 | " |
| 10 | 1/8 | 12 | " |
| 11 | 0 | 12 | " |
| 12 | 0 | 12 | " |
| 13 | — 1/8 | 10 | " |
| 14 | — 1/4 | 7 | " |

*Professor Reynolds' Experiments.—Second Set, where a stronger spring than in last series was used.*

| Number of Experiment. | Depth of Immersion. | Time taken to Run Down. | Remarks. |
|---|---|---|---|
| | | Seconds. | |
| 1 | 3 | 10 | Did not race. |
| 2 | 1 | 10 | " |
| 3 | 5/8 | 11 | Raced at starting. |
| 4 | 1/2 | 11 | " |
| 5 | 3/8 | 9 | Raced intermittently. |
| 6 | 1/4 | 9 | " |
| 7 | 1/8 | 6 | Raced. |
| 8 | 1/16 | 4 | " |
| 9 | 0 | 4 | " |

From the results of these experiments, Professor Reynolds deduces that, so long as the screw is not frothing but working in solid water, the resistance is independent of the depth of immersion, and he calls attention to the point that when a boat is stationary, there is a much greater chance of the screw drawing down air than when it is under way, illustrating his remarks by referring to observations made by him during a voyage on board the Palmyra, whose screw, although eight clear feet under water, frothed the water before there was "way" got on the ship, but did not do so once the vessel was in motion.

In reference to the question of the immersion of screws raised here, the author would call the attention of members to diagram No. 16, which shows Messrs. Harland and Wolf's arrangement fitted to the Britannic, intended to furnish a deep immersion by lowering the screw to an angle with the ship's keel when in deep water, the connection with the engine-shaft being made with a somewhat peculiar universal joint. When in shallow water, the screw is raised so that the tip of the lower blade is above the keel, but at sea the screw is dropped. The results obtained with this arrangement are said to be excellent.

The author now proceeds to the consideration of the second portion of his subject—namely, the shafts and fittings of screw-propellers; about these he ventures to think there is still a good deal to be learned. The best form, as well as the best mode, of fitting a shaft, which has to transmit on occasion the strain of engines exerting, it may be, 8000 horse-power, deserves attentive consideration, more especially when it is remembered that the safety of much valuable property depends frequently on the trustworthiness of a screw-shaft. The whole arrangement of these shafts involves some of the nicest questions of mechanical science. It is at all times a nice matter to centre truly a considerable length of shafting, even to a series of rigid supports, but the difficulty is greatly increased when, as on board a ship, the supports are not rigid, but yield with each strain and "working" of the vessel's hull. The author will refer to one out of numerous examples of the failure—first of a screw, and then of a shaft—illustrating the importance of this question. This was the case of the Atrato, which sailed from Plymouth for Australia, with some hundreds of emigrants on board, on the 17th September, 1873. On the 19th she returned with her screw broken. The damage was made good and she put to sea again, only to return again, however, about the 26th October, with her shaft broken. Diagram No. 17 shows the general nature of the fracture. This second mishap gave rise to a lengthy correspondence between Messrs. James Watt & Co., who made her machinery, and the Board of Trade. By order of the House of Commons, this correspondence was printed. Subsequently the Board of Trade sent a circular to all its marine machinery surveyors—thirty-two in number—requesting them to forward, in a tabulated form, the rules they adopted for calculating the diameters of screw-shafts. This table, which can be seen in the printed report of the Board of Trade, gives respectively the names of ships, the makers of engines, diameters of the cylinders, length of stroke, steam-pressure, diameter of shafting abaft of the crank, and diameter of same as obtained by the rule the surveyor uses. Two columns of the table are bracketed together under the common head of differences between diameters of existing shafting in the vessels named and the sizes obtained by the surveyor's formulæ—the one column containing the amount less than existing shafting, and the other giving the amount greater than existing shafting in the respective vessels named. A list of thirty-eight ships was given. Some of the surveyors used respectively rules of their own, and of the remainder some used Rankine's, some Molesworth's, and some Anderson's rules. The table, No. 11, gives a few of the more striking examples selected from these figures.

*Atrato's Shaft.*

| | |
|---|---|
| Actual diameter of broken shaft | 12 inches. |
| Proper diameter as computed by surveyors:— | |
| By Rankine's rule | 13.7 " |
| " Anderson's rule | 13.4 " |
| " Molesworth's rule | 13.9 " |
| " Caird and Company's rule | 13.4 " |
| " Mr. J. Rose, Hull Surveyor | 14.0 " |
| " Mr. W. Wheatley, Cork | 14.4 " |
| " Spencer's, used by Mr. Bipet, Liverpool Surveyor | 13.3 " |
| " Mr. G. Carlisle, Leith Surveyor | 13.4 " |
| " Mr. R Taplin, Liverpool Surveyor | 13.2 " |
| " Mr. Snowden, London Surveyor | 13.9 " |

Particulars of the engines (compound):—Diameter of high-pressure cylinder, 57 in.; diameter of low-pressure cylinder, 90 in.; stroke 4 ft.; pressure of steam in boilers, 60 lb.; cut-off at about two-thirds stroke in small cylinder.

The sizes of shaft suitable for the Atrato's engines, deduced by the various surveyors, were from ½ in. to about 3 in. greater in diameter than the shaft which broke, and which was 12 in. in diameter; hardly any two surveyors, however, found the same dimension. In the author's opinion, the probable causes of the fracture of shafts and propellers is due, in a great measure, to the almost total absence of any adequate torsional elasticity between the propeller and the engines. Hence, when the screw makes some revolutions out of the water, or it draws down air, then the engines race, and afterwards the screw may become suddenly and deeply submerged, throwing an abrupt strain on the cranks, causing the ship to tremble fore and aft, and some weak point in the shaft probably gives way, leaving the ship a helpless log upon the waves. In the author's opinion, two remedies present themselves for this evil; the one offering the prospect of greatly reducing the chances of fractures taking place, and the other of repairing such fractures when they do come. The former method is to provide some elastic or flexible arrangement between the screw and the engines, so that each could have some movement independently of the other. Common sense dictates this, for the engine is subjected to one set of strains and the screw to another entirely different set, and these two are seldom or never in unison. Hence, there are times when something between the two must give way, whereas, by allowing a little independent motion to the screw, the shocks and strains now so destructive would be avoided.

The introduction of torsional elasticity alone is not enough; some longitudinal elasticity as well is wanted. The diagrams Nos. 18, 19, 20, and 21 illustrate arrangements invented by the author some years ago, to provide torsional and longitudinal elasticity. The torsional is provided for by the cage of flexible blades between the two discs—see Fig. 18. The longitudinal elasticity is provided by arranging the thrust block in a pair of guides T T, in which it can slide and bring the buffers P P to bear against the springs S; while to provide against any violent recoil, the two air cylinders shown at R are bolted at the stern or aft ends of the guides, and in these are pistons packed with cup leathers in such a way that no obstruction is interposed to the forward or thrust motion of the shaft. If a sudden stoppage or reversal of the engines takes place, then no violent recoil can occur, because the pistons encounter a cushion of air, and they can only recede as the air escapes through the two air cocks shown on the aft ends of the cylinders, and these are so designed as to have a leakage space, so that the engineer can never perfectly close them, though he can regulate the degree of rapidity with which the air can escape. Diagram No. 19 shows a simpler plan of providing torsional elasticity than the foregoing, and is intended for steam launches and other small craft. It consists in forming an intermediate portion of the shaft of a single broad steel blade, which affords considerable torsional elasticity. The longitudinal elasticity is provided for by making a square box-end on the one part of the shaft, and a corresponding square end to fit it on the other part of the shaft; this latter bears against a buffer spring within the box; a sectional view is shown on diagram No. 19. Diagram No. 22 illustrates a coupling invented by Mr. F. H. Varley and Mr. E. Furness to secure the same end. It consists of a box, into which is closely but freely fitted a species of piston or block, the one end of which is a simple plane, while the other, or outer end, is shaped as a spiral. The box A in which it works is secured to one length of shafting, while to the corresponding length is fixed the boss B, which has a projection, the extremity of which has a spiral matching that on C. If undue strain comes on the shaft the spiral faces slip, and the block C is forced up against a reservoir of oil, water, or air; or else an elastic india-rubber cushion is interposed. The device is intended either for screw or for factory shafts.

That the principle of such arrangements as have just been described is sound has been demonstrated under severe test, and with great success. Mr. Jeremiah Head, of Middlesbrough, has invented, and successfully applied, an arrangement for introducing torsional elasticity to prevent shock in reversing rolling mills. The arrangement consists in introducing cantilever springs, which are secured at their inner ends to a loose sleeve or box on the mill shaft, while their outer ends engage in projections on the wheels, so that when the clutch is shifted to reverse the movement, the motion is imparted, not through stiff and rigid studs, but through these, so to speak, flexible spokes.

As to the repair of shafts while at sea, the author is of opinion that if shafts were made of an oval section instead of a circular one, they could be more easily repaired. Some misapprehension seems to exist as to the author's meaning in advocating the use of oval shafts, many persons supposing that he seeks to effect the rotation of an oval shaft in a bearing, which is an obvious absurdity. The author only proposes that shafts should be oval between the bearings, having proper journals at suitable points; oval shafts when broken could be clamped without the need of cutting keyways or drilling holes in the shaft, as an oval can not rotate in the clamps, and because shafts break in the journal necks, he suggests that the entire shaft should be oval, and where a bearing is necessary, to put a steel sleeve—see diagram, Fig. 21—fitting the shaft, and having a circular outer face which may rotate in the bearing, when, if torsion break the shaft in the sleeve, the latter will transmit the strain. Several months ago a proposition for effecting the repair at sea of broken shafts was brought before the public by Mr. Cromwell Varley. The scheme consisted of a method of bolting and keying the pieces of a coupling box over the fracture, the weak point of the scheme being that key-ways, or flat places, must be cut on the shaft to prevent its rotating within the box without transmitting any torsional strain or power, which causes dangerous delay at sea in heavy weather. About December, 1872, the author proposed to place an ordinary coupling-box on every length of shaft when first made, to run loosely on the shaft; and when a fracture took place this box was to be slid over the fracture, keyed and bolted up, making at least a good patch.

Diagram No. 23 illustrates a coupling invented by Mr. John G. Winton, of Edinburgh, for repairing broken shafts. He remarked in a paper read before the Royal Scottish Society of Arts, that as screw shafts are usually fitted just as they come from the steam hammer, the repairing coupling can not be properly fitted. He allows an hour and a half as the extreme limit of time for repairing a fracture on board a ship in a heavy sea-way. He proposed two different couplings, the one resembling Varley's, the other being represented in the diagram. The former was to be made in halves, and strongly bolted together, so tightly as to bind the shaft sufficiently to take a part of the torsional strain, while cupped set screws, biting into the shaft, took the rest. The coupling in the diagram, and which does not come at all in contact with the shaft, depending entirely on the set screws, is the second scheme.

In reference to the strength of screw shafts, it may not be out of place to give the opinion of a gentleman of large experience. Colonel Clay, of the Birkenhead Forge Company, states that it is at present difficult to obtain first-class material for heavy shafting, a fact in a great measure due to modern methods of making and refining iron, the use of raw coal, combined with a hot blast, contributing to this. The Jeddo was, some years ago, very unlucky, breaking two shafts in quick succession. A Krupp steel one was then tried, but it only lasted a few weeks, and was found by subsequent test to be too "steely" and brittle. A puddled steel one, supplied by Col. Clay, was next fitted, which lasted well.

An interesting example of what may be done by a skilful engineer under difficulties is supplied by the following case: The Ethiopia, a first-class Atlantic steamer, quite recently broke her shaft, on her voyage to New-York, when about 1500 miles from port, and the fracture was repaired at sea in the manner shown in the diagram No. 24. The shaft is 15 in. in diameter, and the fracture was a simple diagonal one. The broken parts were raised by jack-screws, the edges smoothed, and a 4 in. hole bored through the opposing portions, into which a bolt was tightly fitted. Four steel drivers 4 in. long, 1¼ in. broad, and ¾ in. thick, were sunk into the shaft, flush with its surface, just across the line of fracture. The whole was then tightly clamped by hoops bolted on the shaft. The vessel prosecuted her voyage safely to New-York, and is to come home as she is for repairs, the shaft being considered reliable for the voyage. The repairs occupied eight and a half days, working night and day. Of course this could not have been done in heavy weather.

The author's scheme for repairing broken shafts is shown on diagram No. 21, and diagram No. 21A shows an oval shaft with a separate steel journal neck; this latter receives no torsion till the shaft fail within it, when *it* at once transmits the power past the fracture. Diagrams Nos. 12 and 13 are tables of fractured and defective shafts. The one table No. 12 gives particulars of shafts actually broken at sea, and the ages, mileage and materials are all given, as well as the place and description of fracture. Table No. 13 gives similar particulars of shafts found on examination to be faulty, and therefore condemned.

The data were collected by Mr. Cameron, of the Wilson line of steamers, during his professional career.

In conclusion, the author desires to summarize the foregoing paper by observing that the question of screw propulsion appears to him to depend, so far as the screw itself is concerned, not so much upon any particular form or number of blades fitted to any given propeller, as to the due adaptation of them to the lines of the particular vessels being fitted; that it is a mistake, and causes much needless complication of a subject already difficult, to confound or mix up the economical performance of engines with that of screws; that the performance of a screw can not be measured truly without taking account of the form of hull it acts upon; that the mere measurement of the excellence of hull, engines, and screw can not be alone determined on the basis of the quantity of coal burnt per mile, but that the proportion of dead weight to paying load and also the maintenance cost must be taken account of. Propellers with more than two blades appear to cause the least vibration, and to some extent give a ship a greater margin of safety than the two-bladed screw, because each additional blade is an increased reserve. The author also—while admitting that great progress has heretofore been made in the development of the system of propelling vessels by means of the screw—is of opinion that there are still points of obscurity that need to be cleared up.

## HUMAN HANDS.

A CORRESPONDENT who sends to *Nature* the results of his study of palmistry says: "I have made a collection of more than fifty outlines of the fingers of European hands (right and left). At present I find the tendency in the female hand is to a proportionately longer third than index finger in both hands, than in the male. In all the hands I have examined the third finger of the left hand (when longer than the index) is also proportionately longer than the same finger of the right. In this series I have found only one case of an index longer than the third, and only one in which they were equal (both males). These are all carefully drawn in a pocketbook, care being taken that the hand is perfectly free from any muscular strain, which alters the result appreciably; and the race, sex, and general physical characteristics are noted on the sheet. The list at present includes some classical scholars, a distinguished artist, and numbers of persons of more than average culture; yet there appears to be no correspondence between the mind and the length of the index finger."

[Agricultural Gazette.]

## THE SMITHFIELD CLUB.

THE Seventy-eighth Annual Exhibition of the Smithfield Club was opened December 6th, 1875, at the Agricultural Hall, Islington, where six dozen classes of cattle, sheep, and pigs were submitted to the examination of the Society's judges.

These annual fat-stock shows appear to lose none of the interest which they have so long commanded; and the Smithfield Club exhibition in particular, which contains no animal that has been exhibited at any of the fat-stock shows which have just preceded it, still maintains its supremacy among them all. It must be confessed that the number of these provincial and rival shows is developing a liability to what must be considered an abuse of their original intention—an abuse in which, however, the show has, owing to its exclusiveness, no share whatever. Beyond the mere enjoyment of rivalry and sociability which they afford, these shows are worth nothing to agricultural progress and improvement if they do not contribute to the economy and productiveness of the meat manufacturer. It is that animal which most comes up to the ideal which the cattle feeder seeks for the economical and profitable consumption of his cattle food that deserves the prize of a fat-stock show—not the heaviest animal, nor even the animal of largest frame, not necessarily even the beast for which a butcher will give the highest price per pound—that properly wins the prize; and when it has been exhibited, after being fit for slaughter, any useful purpose it can serve has been accomplished. That, at any rate, is what both societies and spectators would agree upon. "Not at all!" says a wide-awake speculator, who sees in the winner a capacity, not of making further beef with profit, but a capacity of winning further prizes. The animal is kept on, therefore, or purchased (probably at a fancy price) by another, who feeds it for another year, and again and again exhibits it at later shows, and wins gold, gold, gold. He has done nothing wrong in this—the "model" is exhibited again and again, before new spectators, and perhaps stimulates other cattle breeders and feeders to excel it. And if the societies themselves are mere money-making institutions, whose exhibitions are considered failures or successes only as they attract the multitude and collect the shillings, they hardly have the right to throw a stone against the practice. Nevertheless, this repeated exhibition of the same animal is not the object for which fat-stock exhibitions were established; and it is satisfactory to find that the Smithfield Club lends no helping hand to it.

We have endeavored to obtain by photography, and also, to some extent, by measurement, pictures which shall reproduce some of the animals exhibited last week at Bingley Hall. Neither the weather nor the circumstances were very favorable to success, but we give a tolerable representation of the Hereford ox "Birmingham," exhibited by Mr. Robert Wortley, of Aylsham, aged 5 years and 4 months. He won the first prize in his class at Islington last year, was purchased from Mr. Hill, of Orleton, his breeder, who then exhibited him, and reappears to contest the place of the best animal in Bingley Hall. This place has not been awarded him, although many will say that it rightfully belongs to him. The engraver has copied the photograph with accuracy, and as a further illustration of his outline, we give a diagram, which is plotted down from measurement of height, carefully taken. It will be seen from both what a long and low-bodied animal he is, and how grand, especially forward. His extraordinary width, is lost in the elevation.

Mr. Stratton's Nectarine Bud was preferred to Mr. Wortley's Hereford. She is represented in the diagram standing before Lord Ellesmere's Shorthorn ox, which, not noticed by the judges at Birmingham, was preferred to her at the show at Manchester. An attempt has been also made to show in section the size of these two animals, not only in elevation, but in transverse section. Nectarine Bud is close on 30 inches—Lord Ellesmere's ox is 33 inches through the heart, and they both stand at about the same height from the ground at that point—reaching, however, at the back, the one 5 feet 3 inches, and the other 5 feet 6 inches. The outlines here were carefully taken by horizontal offsets in either case, at successive heights of 2 inches, from an upright held close to the side of the animal just behind the shoulder. The resultant sections and the elevation outlines together give a tolerably effective picture of the character of the animals. What can be more perfect, for example, than the shape of Nectarine Bud? Look at her wonderfully true back, and finely-shaped bosom and short legs. See also in the section how perfectly sprung are her ribs—how nearly circular the outline of her body. The somewhat deficient hind quarters may appear to be her only fault. One more, however, must be admitted, and that too is seen in contrast with the outline of the Shorthorn behind her—she is too small for her age. And this may have been the ground of the Manchester decision, and the foundation of our reporter's comment on the unnecessary warmth of feeling with which that decision was then and has been since condemned.

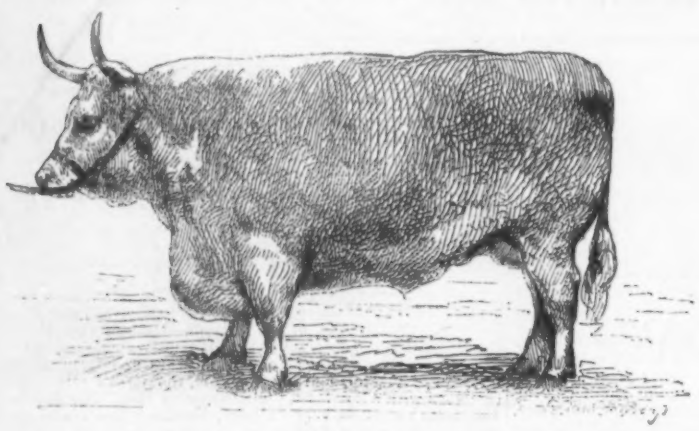


FIG. 1. MR. WORTLEY'S HEREFORD OX "BIRMINGHAM."

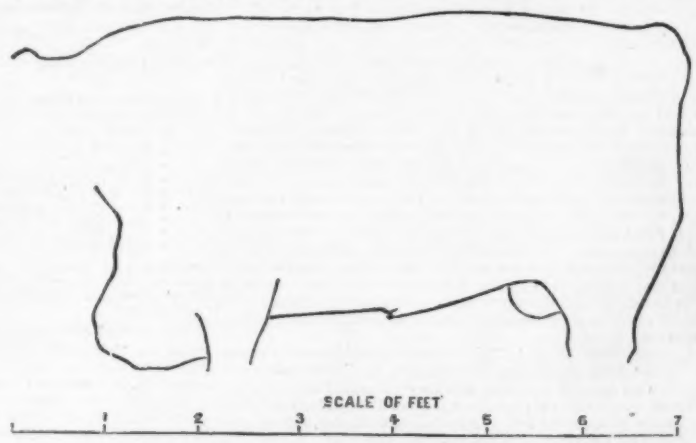



FIG. 3. MR. ROBERT WORTLEY'S HEREFORD OX "BIRMINGHAM."

## A PREHISTORIC DRAWING.

DURING the period when the *Elephas primigenius*, the *Ursus spelæus*, and other prehistoric animals, long since extinct, roamed over Europe, there existed two great deer, both remarkable for the unusually large development of their horns. One, the immense Irish elk (*Megaceros hibernicus*), has totally disappeared, but its fossil remains are found in great abundance in the bogs of Ireland, in the Isle of Man, and in various portions of the continent. The other is the reindeer (*Cervus tarandus*), now an inhabitant of the Polar regions, but then indigenous to southern countries as well. For a long time it was believed that the last mentioned animal never crossed the Alps, but this idea was negatived by the discovery of bones in grottos in Switzerland. Quite recently two new caves have been opened, and the objects exhumed confirm the opinion that the reindeer's habitat without doubt extended into Northern Italy. The new grottos are located near Schaffouse, in Switzerland, and have been named Kesslerloch and Rosenhalle. In the former was discovered the interesting work of prehistoric art represented in our engraving. It is a bone of the reindeer, upon which an ancient Swiss artist has engraved probably with a pointed flint a picture of the animal feeding. The representation is an excellent one, and the boldness and vigor of the drawing prove that the designer possessed cultivated skill. The picture shows the deer in poor condition, indicated by the shrunken belly and meagre flanks, and doubtless dates from a period when the pasturage suitable for the animal had become insufficient for its proper support. This curious old picture serves an excellent purpose as an illustration of the value of a knowledge of drawing. The ancient artist might have written—if he could write—whole tablets of information about the reindeer, and if such tablets had been found we would have been none the wiser, for no one knows any thing about the language of the ancient inhabitants of Europe, and even if symbols like a written language were discovered, there are no rules of modern tongues which could logically be applied to their decipherization. The old Helvetian could draw however, and so in a few strokes he makes a picture which speaks in a language understood by every one.

A PREHISTORIC DRAWING.

## THE FLAX TRADE IN RUSSIA.

THE Commission charged by the Russian Government with organizing, at St. Petersburg, an exhibition of plants suitable for textile manufacture, and of machines for weaving, has addressed to the Government a report which contains the latest statistical information as to the cultivation of flax and the production of the woven fabric in Russia. The following figures give in kilogrammes (1 kil.=2·2 lbs.) the yearly production of flax in the different countries of Europe:

| | |
|---|---|
| Russia | 192,000,000 |
| Austria | 43,952,000 |
| France | 38,096,000 |
| Belgium | 19,056,000 |
| Great Britain | 17,088,000 |
| Italy | 12,208,000 |
| Bavaria | 8,800,000 |
| Saxony | 3,424,000 |
| Other European countries | 7,328,000 |
| Total | 341,952,000 |

It will be seen that Russia is not only the largest producer of flax, but also that her products alone exceed those of all other countries put together. Notwithstanding this enormous production of the raw material, the manufacturers of linen fabrics are far from occupying in the textile industry of the country that preponderance which it would seem they ought to have acquired. In fact, the cotton-mills, and those for the manufacture of stuffs which have this substance as their base, are much more numerous than the flax-works. There are 759 cotton-mills, employing 123,000 hands, while not more than 111 flax-works exist, giving work to only 2000 hands. The Commission attributes this state of things, in the first place, to the defective means adopted by the growers for gathering in the plant itself, and to the rude appliances still in vogue for its preparation; and, in the second place, to the inconvenient situation of the works, which are often very far from the place of production. The Commission recommends that good methods of cultivation be popularized; that the improved machines and processes employed in other countries for treating the stalks be introduced into Russia; and, lastly, that money inducements be offered for the establishment of new works in the centres of production.

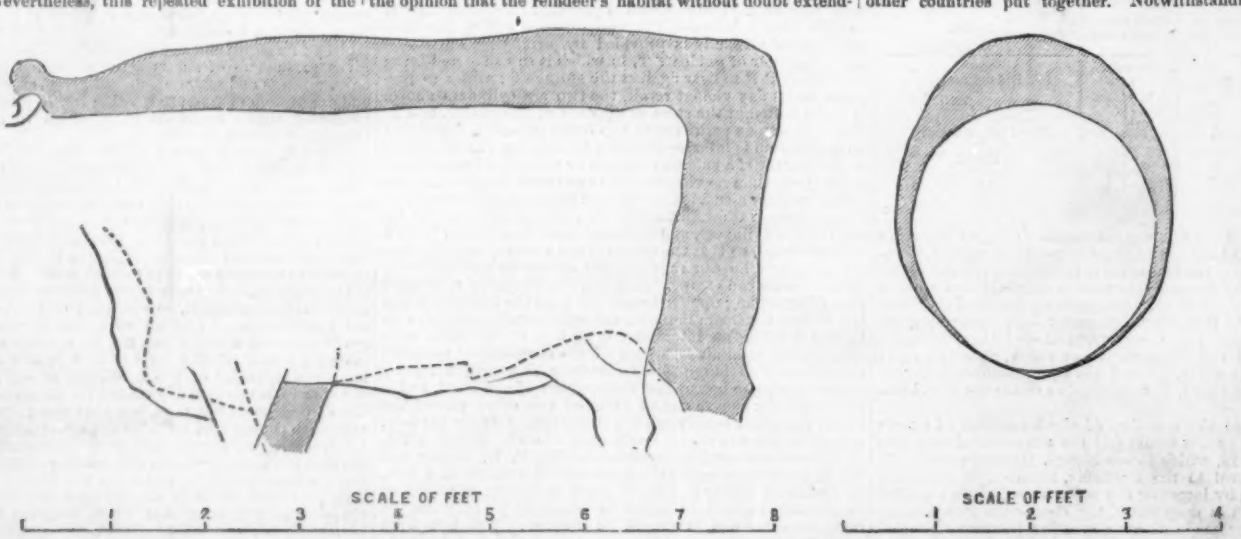



FIG. 2. EARL OF ELLESMERE'S OX AND "NECTARINE BUD"—IN ELEVATION AND IN SECTION.